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NORTHERN VIGOUR OF STRAWBERRY CROWNS: ECONOMIC (PRODUCTION AND MARKETING) FEASIBILITY ANALYSIS AND BUSINESS PLAN DEVELOPMENT

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Northern Vigour® of Strawberry Crowns

Economic (Production and Marketing) Feasibility Analysis and Business Plan Development for Commercialization (Phase 2)

Final Report

ADF Project #19990185

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Abstract

The California strawberry cultivars, 'Camarosa' and 'Chandler', multiplied for one year in Saskatchewan in research tests, express "northern vigour" in the form of early readiness for transplanting and increased yields relative to California-grown plants when used for fruit production in southern California. This study is the third in a series that examines the economic potential of producing strawberry plants (crowns) in Saskatchewan based on these expressions of northern vigour. A major portion of the study presents and analyzes the production and marketing activities of a privately funded commercialization enterprise, Saskatchewan Strawberry Plant Producers (SSPP), in 2000. SSPP produced certified-level 'Camarosa' strawberry plants at Pike Lake, Saskatchewan and sold them to strawberry fruit producers in southern California. While the venture was not financially successful in its first year, SSPP developed customer interest in California and amassed a large amount of knowledge about production, financial, regulatory and marketing requirements at a commercial scale. This study makes this information available to prospective producers of strawberry plants and to government agencies involved in providing technical, regulatory or other assistance. The study also looks at the potential for developing an industry in Saskatchewan that produces all of the levels of strawberry plants in the certification hierarchy from nuclear stock to certified stock. The economic potential of several specific yield-enhancing production practices currently being researched is examined. These include floating row covers, pre-planting fumigation, fertilizer, herbicide and hormone applications, tissue culturing and two-year production cycles. The study concludes that the SSPP experience, despite its initial difficulties, shows that there is economic potential for marketing Saskatchewan-grown strawberry plants in California, given the continued interest of California customers. There also are other market opportunities in Florida and in Western Canada. However, the average number of marketable daughter plants produced per mother plant must be increased, labour costs must be reduced and a number of regulatory obstacles must be minimized or overcome. The need for soil fumigation remains an unresolved issue. It is recommended that further public research be undertaken to address a number of production, marketing and regulatory problems that inhibit the development of strawberry plant production in Saskatchewan.

Executive Summary

Research by University of Saskatchewan scientists indicates that propagating the California strawberry cultivars 'Camarosa' and 'Chandler' for one growing season in Saskatchewan can increase the vigour of the resulting daughter plants (crowns) when transplanted for fruit production in southern California. This "northern vigour" is expressed as healthy daughter plants that are ready for transplanting earlier than plants produced in California nurseries and that produce higher fruit yields.

The presence of northern vigour in strawberry plants could have economic benefits for Saskatchewan. Southern California strawberry fruit producers indicate they would be willing to pay a premium for nursery plants that are available earlier and that have increased fruit yields relative to the plants they currently purchase from nurseries in northern California. They are also interested in new, disease and pest free sources of nursery plants. Saskatchewan already benefits from the presence of northern vigour in other crops. The principal example is the seed potato industry that is based on the presence of northern vigour in potato seedstock grown in the province.

This study is the third study funded by the Agriculture Development Fund (ADF) to look at the economic potential of producing strawberry nursery plants in Saskatchewan. It improves and updates the economic and business analysis begun in the first two studies, complementing the continuing horticultural research at the University of Saskatchewan on northern vigour in strawberry plants.

The initial study (Lokken, Brown, Taylor, Tanino, Bandara and Ward, 1998) described the supply and demand for strawberry plants in North America and presented a preliminary analysis of the economics of production, processing and marketing from a Saskatchewan perspective.

The second economic study (Lokken, Storey, Allen and Tanino, 2000) provided a more detailed economic analysis of the potential for Saskatchewan-produced plants to capture markets and price premiums, especially in California. It also presented a detailed physical and financial description of the production process for strawberry plants, as observed at a variety of strawberry nurseries across North America and adapted for Saskatchewan conditions. Southern California was identified as the initial principal market opportunity for Saskatchewan-produced strawberry plants because of the large size of the market, the connections established with the area through the years of research, and the specific interest of southern California strawberry fruit growers in the early availability and high early-season yields of Saskatchewan plants.

Yield of daughter plants and selling price were identified in Lokken et al. (2000) as the two factors that would have the greatest impact on the return on investment. Other important factors affecting the profitability of production were the availability, skill and cost of labour, especially during processing, and whether soil fumigation was used. Labour scarcity and regulatory constraints affecting the movement of plants across borders were identified as adding a high level of risk to production of plants in Saskatchewan for sale to California.

The second study also examined a variety of business arrangements and strategies that might be employed to develop a crown production industry in Saskatchewan that could successfully capture a share of the California market. The study concluded that Saskatchewan-grown strawberry plants with consistent expression of northern vigour have the potential to capture a significant portion of the southern California market and could command significant price premiums over California nursery plants based on the added revenue the northern vigour plants would provide to fruit growers. Saskatchewan faces the probability that other areas of western Canada will attempt to capture shares of the same market since northern vigour is not confined within the borders of Saskatchewan.

The current study (Lokken, Storey and Tanino, 2002) expands the examination of the economics of strawberry plant production in Saskatchewan begun in the previous studies. It would be useful to have access to the first and second studies if the current study is to be read in detail, since reference is made to research in those studies throughout. A major portion of the study is taken up with the description and analysis of the production and marketing experiences of Saskatchewan Strawberry Plant Producers (SSPP), a private partnership that, in 2000, began the first commercial production of strawberry plants in Saskatchewan, and, as far as is known, in the prairie provinces. SSPP made its 2000 production and marketing records and experience available for analysis in this study. The commercial activities of SSPP provide a large amount of production and marketing information that would have been difficult to develop through purely academic research.

SSPP was granted a license in early 2000 by the University of California to multiply its patent-protected strawberry cultivar 'Camarosa'. SSPP produced 'Camarosa" strawberry plants in 2000 on ten acres at Pike Lake, Saskatchewan for sale to southern California strawberry fruit growers who had ordered plants in early 2000 at a significant price premium to the northern California nursery plants that they usually use. A temporary field and processing plant inspection system was set up with the cooperation of Saskatchewan Agriculture and Food, the University of Saskatchewan and the Canadian Food Inspection Agency in order to meet California's stringent regulatory requirements. Field production at the Pike Lake location in 2000 was relatively successful. Even though a number of production mistakes were made because of lack of information and experience, the production of high quality marketable plants (estimated 615,000 in the field) approached the number that had been estimated as the economic breakeven number (675,000). Several relatively simple changes in production methods and labour management have the potential to increase yields significantly.

SSPP was not as successful at bringing the plants through the processing and shipping process as it had been with field production. SSPP had decided to produce in 2000 without fumigating the soil prior to planting because nematodes were not expected to be a problem. Nematodes were discovered in the plants just at harvest time and harvest was

delayed for a week while more tests were completed to see if the plants would be acceptable in California. It was determined that they would be acceptable but the delay meant that the delivery window to the California customers was cut in half since they were rapidly finishing up planting. It was not possible, nor was it economically feasible given the labour resources available, to harvest all of the SSPP acres in the week that remained. Only seven of the ten acres were harvested. 305,000 plants were sent to California, about half of what had been originally estimated as available.

Although the regulatory hurdles that were faced at the international, state and county borders were handled without problems, the delivery of the plants was complicated by the fact that some of the plants had started to spoil in the boxes. Heavy frosts experienced during harvest are believed to have caused the loss of plants in storage. In addition, it was observed that SSPP had been too rigorous in rejecting plants by size and root development and had needlessly rejected probably one third of its marketable plants in the processing operation. Payment was delayed on the plants because of the spoilage. Customers eventually paid for about 220,000 plants.

The SSPP commercialization initiative was not financially successful in 2000. The major factors that made it unsuccessful were the delay due to nematode infestation, the heavy frosts during harvest and the high cost/low productivity of labour both in the field and in the processing operations. The operation had a high risk attached to it because of the regulatory uncertainty attached to access to the California market. As a result of these issues, SSPP did not produce strawberry plants in 2001 and likely will not in 2002. Some of the SSPP partners continue to evaluate the potential for future production and maintain the production license since the California customers have continued to expressed interest in Saskatchewan-grown plants.

The current study examines a number of other issues laid out in the original ADF project objectives that the activities of SSPP did not address. These include a survey of various certification systems for strawberry plants in other provinces and California, an analysis of the requirements for, and costs of, developing a "closed" Saskatchewan certification

system, and an examination of the potential for producing and marketing northern varieties of strawberry plants. Various yield-enhancing strawberry plant production techniques that are currently being researched at the University of Saskatchewan California are also analyzed from an economic perspective. These include floating row covers; fumigation; fertilizer, herbicide and hormone applications; tissue cultured plants; and two-year production cycles. The horticultural research on many of these techniques has not progressed very far because of various production problems and not enough years of tests so the economic analysis is by no means complete. It is, however, valuable to subject the horticultural tests to economic measures at each stage of the research.

The following summarizes the various sections of the current study. The conclusions and recommendations are presented at the end of the summary.

Section 1 introduces the research completed in this project and makes connections to the previous economic and horticultural research in the area.

Section 2 provides a general description of the organization of SSPP, its production, processing and marketing activities in 2000 and a brief assessment of its financial difficulties in 2000.

Section 3 breaks the SSPP production process in 2001 into its constituent parts for detailed discussion and analysis. SSPP's actual methods of production, costs and returns are compared and contrasted with the production process, costs and returns estimated in *Study 2*. This comparative analysis provides a much greater understanding of the specific requirements and costs of commercial production in Saskatchewan than was previously available.

Section 4 describes the market development work carried out by the researchers in California and details the marketing activities of SSPP in 2000. The implications of the presence of nematodes in the Saskatchewan plants, the processing and shipping

difficulties SSPP experienced and the yield results from the Saskatchewan plants grown in southern California in 2000 and 2001 are discussed in this section.

Section 5 describes the licensing, regulatory and inspection requirements that producers will have to fulfill to export to California. There are a number of problems in this area that were highlighted by the SSPP experience in 2000 and must be solved if the risk of future plant production in Saskatchewan for sale into California is to be manageable.

Section 6 discusses the impact that various business arrangements could have on the ability of a Saskatchewan production to successfully export plants to California. Particularly because of regulatory issues, it may be necessary for a Saskatchewan plant production company to form some type of business alliance with California interests in order to overcome the regulatory disadvantages a non-California nursery faces.

Section 7 considers other research objectives not addressed by the analysis of the SSPP operation. The requirements for, and impediments in the way of, producing strawberry plants in a "closed" certification system that is not dependent on California nurseries for mother plant material are laid out. The authors then present information on other certification systems in Canada. The economic potential of producing northern varieties of plants for the Canadian and northern US market is discussed. The economic potentials and regulatory and market implications of various yield improvement techniques currently being studied at the University of Saskatchewan are analyzed. These yield improvement techniques include floating row covers; pre-plant fumigation; fertilizer, herbicide and hormone applications; tissue culturing; and using two year production cycles.

Section 8 presents a number of conclusions drawn from the research on the economic feasibility of strawberry plant production in Saskatchewan. These conclusions have implications for further economic and horticultural research and industry development. The section then presents a series of specific recommendations on the future requirements for, and direction of, public research into the production and marketing of northern

vigour strawberry plants and regarding the initial steps that need to be undertaken to begin industry development and provide a supporting regulatory structure.

Conclusions

Conclusion #1: Production and Marketing Feasibility
The production of strawberry nursery plants (crowns) in Saskatchewan for sale to southern California fruit growers has the potential to be economically feasible if key areas of concern are adequately addressed. This conclusion is based on the research results presented in Study 2 and the experience gained from the commercial SSPP operation in 2000.

Conclusions #2 to #7 provide the basis for Conclusion #1.

Conclusion #2: Field Production Methods
Production research must focus on maximizing, within economic constraints, the plant multiplication rate (the number of marketable daughter plants produced per mother plant).

Conclusion #3: Processing and Shipping Methods
Research in this area must focus on methods of trimming, packing and shipping plants with the objective of maximizing, within economic constraints, the number of successfully marketed plants.

Conclusion #4: Labour Supply
An adequate source of affordable and sufficiently skilled labour must be identified so that the required field and processing operations can be carried out in both a timely and economical manner.

Conclusion #5: Regulatory Issues
Saskatchewan nurseries must be confident that they can meet California's regulatory requirements consistently. Acceptance of Saskatchewan plants by California officials must occur before the plants reach their destination. Leaving the approval to county officials at the point of unloading is a risk that a developing strawberry plant industry cannot afford. Current California inspection conditions, unless improved, will hinder the development of a production industry here.

Conclusion #6: Marketing to Southern California Growers
Southern California growers are interested in using Saskatchewan as a new source of plants provided that Saskatchewan growers are able to meet their requirements in terms of plant quality and delivery conditions.

Conclusion #7: Price Premiums for Saskatchewan Plants
Saskatchewan growers must be able to obtain a price premium for Saskatchewan plants relative to the price paid for the best high elevation California plants.

Conclusion #8: Introduction of New Varieties
Saskatchewan strawberry plant production destined for California is vulnerable to losing market share to new patented strawberry varieties available only to California nurseries in the first years after release.

Conclusion #9: Closed Certification System
A closed provincial certification system needs further research and consideration.

Conclusion #10: Other US Markets
There is market potential in Florida and other southern states for Saskatchewan-grown plants (southern varieties).

Conclusion #11: Production of Northern Varieties
The production of northern varieties of strawberry plants to sell into markets across Canada and the United States is of secondary interest to Saskatchewan.

Conclusion #12: Public Horticulture and Economic Research
Further publicly-funded horticultural and economic research remains necessary at this point in time.

Recommendations

Recommendation #1: Southern California Field Trials
Continue field trials of Saskatchewan-grown plants in southern California.

Recommendation #2: Other Field Trials
Begin research trials in other parts of California and other areas of the southern U.S.

Recommendation #3: New Strawberry Cultivars
Begin testing of new California and Florida strawberry cultivars for northern vigour as soon as they are available. Work on developing suitable Saskatchewan cultivars.

Recommendation #4: Industry Intelligence and Market Development
Continue to develop contacts with researchers and plant and fruit producers across North America. Continue to gather and analyze production, economic and market information.

Recommendation #5: Regulations
Begin to plan appropriate regulations and inspection regimes in Saskatchewan and pursue favourable California regulatory status for Saskatchewan plants.

Recommendation #6: Production and Processing
Develop commercial production and processing practices suitable for Saskatchewan. There is a need for more public research in the following areas:

- *Plant Productivity*
- *Field Production Methods and Practices*
- *Nematode Testing and Fumigation*
- *Harvesting Machinery*
- *Processing, Packing and Shipping Methods and Practices*
- *Labour Requirements and Sourcing*

Recommendation #7: Closed Certification System
Continue research on a closed certification system for Saskatchewan.

Recommendation #8: Northern Variety Production
Continue research into the production, storage and marketing of northern varieties.

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Section 1. Introduction and Study Outline

1.1. Introduction

Research by University of Saskatchewan horticulture scientists has shown that propagating the California strawberry cultivars 'Camarosa' and 'Chandler' for one growing season in Saskatchewan can increase the vigour of the resulting daughter plants (crowns) when transplanted for fruit production in southern California.[1] This Northern Vigour® has been expressed as healthy daughter plants that are ready for transplanting earlier than plants produced in nurseries in California and that produce higher early season and season-long fruit yields in southern California relative to California nursery plants.[2] The vigour of the Saskatchewan-grown plants relative to California-grown plants has varied from year-to-year through the research period. Saskatchewan plants were significantly superior to California plants in terms of early yield and season-long yield in research plot tests on the cultivar 'Camarosa' from 1995 to 1998 and in field trials in 1999. Field trials in 2000 and 2001 have been less clear in establishing the superiority of the Saskatchewan plants. Given this variability in results, more research is required to determine whether production in Saskatchewan will consistently produce the expressions of vigour shown in some previous years.

The expressions of northern vigour in strawberry plants have potential economic benefits for Saskatchewan if they can be produced consistently. Saskatchewan has benefited from

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[1] The results of the horticultural research are presented in several studies listed in the reference section of this study including Krieger and Tanino, December 2001; Krieger and Tanino, February 2001; Krieger and Tanino, December 2000; Krieger and Tanino, November 2000; Krieger and Tanino, May 2000; Krieger and Tanino (1999), Bandara and Tanino (1998). The results from the 2001growing season in California are discussed in Section 4 of the present study and will be published in a final report by the horticultural researchers.

[2] Northern Vigour is the registered trademark of the Saskatchewan Seed Potato Growers Association. Northern Vigour is used in this study to refer to the superior expression of various characteristics of plants when grown at high latitudes. These characteristics may include early maturation, increased yields, more vigorous growth, and/or increased levels of important constituents. Low levels of disease and pests are often related attributes. Saskatchewan's geographical location, climate, temperature and day length

the presence of northern vigour in other crops. The principal example is the thriving seed potato industry that is based on the presence of northern vigour in potato seedstock grown in the province. This industry has grown from 400 acres in 1990 to 6,500 acres in 2000. The gross value of production is approximately $2,000 per acre. Seedstock is sold into eastern Canada, Manitoba, Washington State, California and Mexico (Waterer, personal communication, 2001).

Southern California strawberry fruit producers who have cooperated in field trials of Saskatchewan-grown plants indicate that they are willing to pay a premium for vigorous nursery plants that are available for transplanting earlier than those they are able to access now from northern California nurseries and that have increased fruit yields, especially in the early part of the season when fresh strawberry prices are at their peak. They are also interested in new disease and pest free sources of nursery plants because of the imminent prohibition on the use of the soil fumigant methyl bromide, the current primary soil sanitation tool in the production of both strawberry nursery plants and strawberry fruit in California. It is unclear whether nurseries in California will be able to produce clean, healthy plants with replacement fumigants. The California industry is very concerned with this issue.[3]

This study is the third of three successive studies funded by the Agriculture Development Fund (ADF) that have looked at the economic potential of producing strawberry nursery plants in Saskatchewan.[4] The present economic study was undertaken to improve and update the economic and business analysis begun in the first two studies, thereby keeping current with and complementing the horticultural research on northern vigour in strawberry plants as it progresses. Describing and analyzing the economics of production

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variations, amount of sunlight and relatively brief and limited agricultural development contribute to northern vigour in ways that scientists are only beginning to understand and quantify.

[3] The California Strawberry Commission, which represents strawberry fruit growers, claims to have the largest research program in the United States looking at finding alternatives to methyl bromide. It provides over one million dollars in funding support for this research annually and considers the research a major focus of the organization (California Strawberry Commission, 2001).

[4] It would be useful to have access to the first and second studies (Lokken, Brown, Taylor, Tanino, Bandara and Ward, 1998) and Lokken, Storey, Allen and Tanino, 2000) if the current study is to be read in detail, since reference is made to research in those studies throughout the current study.

and marketing concurrently with the progress of the horticultural research has been deemed important so that potential Saskatchewan producers can adequately assess both the physical and economic feasibility of commercial production. Northern vigour is unlikely to be confined within the borders of Saskatchewan. Saskatchewan needs to have a complete package of information available if agriculture in the province is to capture any advantages that northern vigour may confer, before producers in other jurisdictions undertake competing production.

Lokken, Brown, Taylor, Tanino, Bandara and Ward (*Study 1,* 1998) examined the economic potential of northern vigour in Saskatchewan-grown strawberry plants, garlic and a number of herbs. That study provided an introductory overview of potential market and production opportunities and constraints for strawberry plant production. It described the existing supply and demand for strawberry plants in North America and presented a preliminary analysis of the economics of production, processing and marketing in Saskatchewan.

Lokken, Storey, Allen and Tanino (*Study 2,* 2000) provided detailed strawberry plant market and production information specific to the Saskatchewan situation.[5] It presented an economic analysis of the potential for Saskatchewan-produced plants to capture markets and price premiums. It also provided a detailed physical and financial description of the production process for strawberry plants, including spreadsheet financial analysis.

In *Study 2*, southern California was identified as the initial principal market opportunity for Saskatchewan-produced strawberry plants for a number of reasons, including:

- the southern California market for plants comprises a large percentage of the total demand for strawberry plants in North America in a concentrated geographical area;

[5] Lokken, Brown, Taylor, Tanino, Bandara and Ward (1998) and Lokken, Storey, Allen and Tanino (2000) are referred to as *Study 1* and *Study 2* respectively throughout the remainder of the present study.

- fruit growers in southern California require plants earlier in the fall of each year than do areas further north in California and pay premium prices for early, vigorous plants. These growers are interested in sourcing nursery plants that will allow them to push planting dates further forward than is currently possible with California grown nursery plants;

- almost all southern California strawberry fruit acres currently are planted to the variety 'Camarosa', which is the variety that has been tested most extensively in Saskatchewan; and

- although Florida is another major potential market for early strawberry plants, it is a smaller market. It makes use of a number of strawberry varieties and is further away from Saskatchewan than southern California, so is deemed to be of secondary importance. However, Florida could potentially provide an economical market for Saskatchewan plants. It may have some advantages over the California market, including fewer regulatory restrictions on imported plants.

Study 2 estimated the annual southern California demand for strawberry plants, the share of this market that Saskatchewan-grown plants with northern vigour might be able to capture and the potential for the extraction of price premiums for northern vigour from this market under small market and large market conditions.[6] These projections were based on estimates of demand elasticities for strawberry fruit in North America, strawberry fruit acreage and production in southern California, fruit and plant price data, and the 1999 field test results from Saskatchewan plants used for fruit production in southern California. The study showed that, if Saskatchewan can produce plants that perform similarly to the plants in the 1999 field tests, southern California fruit growers should be willing to pay a premium of 30 per cent to 50 per cent over the highest plant

[6] For the purposes of this discussion, southern California comprises approximately 8,600 acres of strawberry fruit production in Ventura County (just north of Los Angeles), Los Angeles County and Orange County (just south of Los Angeles). This is about one third of California's total strawberry acreage and requires an estimated annual input of 200 million nursery plants or about one quarter of North American demand.

prices paid now, based on the increased net revenue they would gain from the use of Saskatchewan plants.

Study 2 also included a financial analysis over ten years of a hypothetical base scenario for a commercial production operation in Saskatchewan and provided a spreadsheet template for use by potential producers in developing their own production scenarios. The cost of production estimates were developed using information collected from strawberry plant producers in eastern Canada and California and adjusted for Saskatchewan production and market conditions. Plant multiplication rates and plant selling price were identified as the two factors with the greatest impact on the return on investment. Other important factors affecting the profitability of production were the availability, skill and cost of labour, especially during processing, and whether soil fumigation was used. Labour scarcity and regulatory constraints affecting the movement of plants across borders were identified as adding a high level of risk to the production of plants in Saskatchewan for sale to California.

Study 2 then examined a variety of business arrangements and strategies that might be employed to develop a crown production industry in Saskatchewan that could successfully capture a share of the California market. These included independent Canadian business arrangements as well as various strategic alliance and partnership arrangements with American crown or fruit producers.

The study concluded that strawberry plants with northern vigour from Saskatchewan have the potential to capture a significant portion of the southern California market and could command significant price premiums over California nursery plants based on the added revenue the northern vigour plants would provide to fruit growers. However, Saskatchewan faces the probability that other areas of western Canada will attempt to capture shares of the market for plants with northern vigour, similar to the situation in the seed potato industry where Alberta and Manitoba, as well as Saskatchewan have significant production. Alberta is already carrying out tests on California strawberry plants multiplied for a year in the Peace River area.

On the production side, it was concluded that increases in plant multiplication rates, careful management of labour and the reduction of regulatory risk will be key requirements of profitable production.

1.2. Scope of the Current Study

Study 2 was completed some time after the present project had been approved and funded. A large amount of information that the authors assembled to fulfill the objectives of this third study, including revisions and improvements to both the market analysis and cost of production estimates, was incorporated into the second study's final report. Thus, the *Study 2* report was far more detailed and inclusive than planned for in the objectives of the second project or provided for in the resources made available for that project.

The *Study 2* research demonstrated that there should be a market demand, especially in southern California, for the particular traits of northern vigour expressed by Saskatchewan-grown plants. The size and value of this total market were described and estimates made as to how much of that market and what price premium might be captured by Saskatchewan production under various market scenarios. The regulatory hurdles that would have to be overcome were identified and described. Careful estimates were made of the various costs of commercial production and marketing based on information gathered from strawberry plant producers in Eastern Canada and California and adjusted for Saskatchewan conditions. The most important production and marketing constraints were identified and analyzed.

Even after the extensive analysis presented in *Study 2,* there were still many research issues that required attention. Additional detailed economic analysis of these issues based on additional observation of strawberry plant production and markets in other parts of North America would have greatly enhanced the knowledge base established in *Study 1* and *Study 2*. However, the step that would significantly advance the production and economic research and provide useful information to prospective strawberry plant

producers was for production and marketing under commercial conditions to take place in Saskatchewan.

The resources of the horticultural and economic research projects were not large enough to undertake such production, nor would such production be appropriate for university researchers to undertake. Given this need to move the research forward and because of the commercial potential indicated in the horticultural and economic studies, three of the authors of *Study 2* and two other University of Saskatchewan researchers decided to create a private business partnership to investigate the commercial potential of strawberry nursery plant production in Saskatchewan.[7] This business, Saskatchewan Strawberry Plant Producers (SSPP), was set up as a completely privately financed profit-oriented operation.[8] However, this business also was formed to further the research in strawberry plant production to create benefits for Saskatchewan. SSPP cooperated with university researchers in 2000 by making land available for experimental plots and by providing testing material from its own production. It has made its production records and market development and marketing information available for analysis in the current study, including fruit production results from its California customers. The university and governments, for their part, played an important role in SSPP's operations. SSPP's budgets and production process were based on the various studies produced at the university. Many of the production, marketing and inspection problems in 2000 were discussed and worked out through cooperation with University of Saskatchewan researchers, Saskatchewan Agriculture and Food (SAF) specialists and the Canadian Food Inspection Agency (CFIA).

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[7] This business was formed as a general partnership in March 2000 named Saskatchewan Strawberry Plant Producers. The five equal partners in Saskatchewan Strawberry Plant Producers are Professor Tom Allen, James Lokken and Dr. Gary Storey, Department of Agricultural Economics, Tom Ward, Department of Plant Science and Dr. Marv Painter, College of Commerce, all of the University of Saskatchewan. Among the five partners there is academic and practical expertise in horticultural production, farm and business management, accounting and marketing. In addition, all five partners either are or have been active farmers involved with a wide variety of crops and livestock. James Lokken, Gary Storey and Tom Allen were authors of *Study 2*.

[8] No ADF research funding was used to carry out the activities of SSPP. When ADF research activities coincided with SSPP business activities, such as the market development visits by Dr. Gary Storey and James Lokken to California in February 2000, the costs were allocated appropriately.

Much of the following study describes the production and business activities of SSPP over the full cycle of production, processing and marketing of a crop in 2000. The study uses this information to improve and expand the analysis of the economic potential of strawberry plant production in Saskatchewan begun in the previous studies. Access to the records of a year of commercial production provides a wealth of practical information that would have been difficult to assemble under university research conditions. The practical problems of commercial production in Saskatchewan that became apparent over the course of the year suggest the direction further publicly-funded research should take and the relative importance of various future avenues of research.

The study also examines a number of other issues laid out in the original project objectives and description that the activities of SSPP did not address. These include a survey of various certification systems for strawberry plants in other provinces, an analysis of the potential for, and costs of, developing a "closed" Saskatchewan certification system, and an examination of the potential for producing and marketing northern varieties of strawberry plants. Various yield-enhancing production techniques that are currently being researched at the University of Saskatchewan California are also analyzed from an economic perspective.

1.3. Outline of the Current Study

Section 2 provides a general description of the organization of SSPP, its production, processing and marketing activities in 2000 and a brief assessment of its financial difficulties in 2000.

Section 3 breaks the SSPP production process in 2001 into its constituent parts for detailed discussion and analysis. SSPP's actual methods of production, costs and returns are compared and contrasted with the production process, costs and returns estimated in *Study 2*. This comparative analysis provides a much greater understanding of the specific requirements and costs of commercial production in Saskatchewan than was previously available.

Section 4 describes the market development work carried out by the researchers in California and details the marketing activities of SSPP in 2000. The implications of the presence of nematodes in the Saskatchewan plants, the processing and shipping difficulties SSPP experienced and the yield results from the Saskatchewan plants grown in southern California in 2000 and 2001 are discussed in this section.

Section 5 describes the licensing, regulatory and inspection requirements that producers will have to fulfill to export to California. There are a number of problems in this area that were highlighted by the SSPP experience in 2000 and must be solved if the risk of future plant production in Saskatchewan for sale into California is to be manageable.

Section 6 discusses the impact that various business arrangements could have on the ability of a Saskatchewan production to successfully export plants to California. Particularly because of regulatory issues, it may be necessary for a Saskatchewan plant production company to form some type of business alliance with California interests in order to overcome the regulatory disadvantages a non-California nursery faces.

Section 7 considers other research objectives not addressed by the analysis of the SSPP operation. The requirements for, and impediments in the way of, producing strawberry plants in a "closed" certification system that is not dependent on California nurseries for mother plant material are laid out. The authors then present information on other certification systems in Canada. The economic potential of producing northern varieties of plants for the Canadian and northern US market is discussed. The economic potentials and regulatory and market implications of various yield improvement techniques currently being studied at the University of Saskatchewan are analyzed. These yield improvement techniques include floating row covers; pre-plant fumigation; fertilizer, herbicide and hormone applications; tissue culturing; and using two year production cycles.

Section 8 presents a number of conclusions drawn from the research on the economic feasibility of strawberry plant production in Saskatchewan. These conclusions have implications for further economic and horticultural research and industry development. The section then presents a series of specific recommendations on the future requirements for, and direction of, public research into the production and marketing of northern vigour strawberry plants and regarding the initial steps that need to be undertaken to begin industry development and provide a supporting regulatory structure.

Section 2. Saskatchewan Strawberry Plant Producers (SSPP): A Brief Description of its Business Activities in 2000

This section explains the rationale for the formation of Saskatchewan Strawberry Plant Producers (SSPP) and provides a brief chronological description of the production and marketing activities of SSPP in 2000.

SSPP was formed in March 2000 to undertake the first commercial production of strawberry nursery plants in the Canadian prairie provinces, as far as is known. The impetus for taking this action at that time arose from several different sources:

- The horticultural and economic studies to that time suggested that there was potential for profitable production in Saskatchewan based on marketing the attributes of northern vigour to southern California fruit growers;

- Despite the extensive research that had been carried out in this area, there were still large gaps in the understanding of production and marketing that academic research could not easily fill. Commercial-scale production would provide information obtainable in no other way;

- Strawberry fruit producers in southern California who had been exposed to the research work on northern vigour had expressed interest in field testing Saskatchewan plants on a larger scale than university researchers could accommodate. It was considered to be important to capitalize on that interest before it waned or shifted elsewhere;

- Interest was growing in the northern vigour research on strawberry plants in other provinces, particularly Alberta, and the possibility existed that production could begin there first, leaving Saskatchewan in a "catch-up" position;

- Given the pressure to begin production in Saskatchewan ahead of Alberta, the current interest by California producers in Saskatchewan plants and, at the same time, the gaps in the research information, the university researchers who formed the partnership felt that someone in the research community should be the first to assume the risks of commercial production to advance knowledge in the area and to keep Saskatchewan at the forefront of the research.

The following description of SSPP's activities in 2000 is presented in chronological order in an abbreviated form. Detailed discussion of the production and marketing process can be found in later sections of this study.

November 1999 – February 2000

Several university researchers began to look at the possibility of forming a production company after reviewing the findings of *Study 2*. Analysis based on the production and market information presented in that study suggested that a ten acre production operation would be of sufficient scale to test commercial production, yet would be small enough to be physically manageable and keep the risk at a manageable level.

There were a number of issues to explore before there could be a commitment to production in 2000. In order to propagate 'Camarosa' plants it was necessary to obtain a license from the University of California which holds the patent on that cultivar. This process was initiated in December 1999.

It was also necessary to secure some commitment from customers for the product. In February 2000, Dr. Gary Storey and James Lokken met with a number of prominent strawberry fruit growers in southern and central California as part of the market development objective of the present ADF project. The purpose of the meetings was to inform California producers about the research on northern vigour and begin the process of developing market interest and marketing links. After the research information had been presented and information had been exchanged on market opportunities and

production concerns, growers were asked if they were interested in purchasing plants from Saskatchewan for planting in the fall of 2000. The plants were priced at US $0.09 cents per plant, a 50 per cent premium over the price of the best plants available in California. The high price was explained as a premium for the superior quality of the plants based on the previous year's research results and as an investment in developing a new source of plants. Seven southern California growers representing between 1,500 and 2,000 acres of strawberry production in total agreed to purchase plants. They each gave a minimum and maximum number they would purchase with total orders in a range of 440,000 to 540,000 nursery plants. A range of plant numbers was used to give some protection to both fruit growers and SSPP. SSPP was not sure how many plants it could produce but saw this range as a reasonable middle ground from which to start, given yields in past research tests and the uncertainties of production. If production could exceed the maximum number ordered there was a good indication from the California growers that there would be buyers for the extra plants.

The third prerequisite to starting production was locating suitable land with irrigation capability. Preliminary arrangements were made near the beginning of 2000 for the rental of land on the west bank of the South Saskatchewan River near Pike Lake. This land is irrigated by a pivot that draws water from the river. The landowner also was willing to supply most of the required machinery to SSPP on an hourly rental basis, including a small tractor with cultivator and rototiller, a mint harvester which appeared as if it would serve for harvest purposes (with slight modifications), a large tractor to pull the harvester and trucks for hauling harvested material.

March – mid-April 2000

While the licensing process with the University of California (UC) was not completed until the first part of April, permission was received from University of California's Office of Technology Transfer to order registered plants in March. Given that the prerequisites for production - seedstock, land, machinery, and customers had been arranged - SSPP was formally constituted as a partnership at that time. All the financial capital was provided by the five partners, who also guaranteed to contribute labour and

management time over the course of the production and marketing process. One partner, James Lokken, was hired on an hourly wage to manage the day-to-day activities of the partnership, over and above his contribution of time as a partner. His pickup truck was leased at a rate reflecting its intermittent use in the strawberry operation.

In late March 2000, 103,000 registered 'Camarosa' plants in total were ordered from the two largest plant nurseries in California, Lassen Canyon (52,000 plants) and NorCal (51,000 plants). Transport of these plants was arranged with Martin's Vegetables of Saskatoon and costs were shared with two strawberry fruit producers near Saskatoon who were also ordering plants from California. The plants arrived on April 8, 2000 without any complications and were stored in the University of Saskatchewan greenhouse coolers. A completed license agreement was received from the University of California at about the same time, giving SSPP the right to propagate and sell 'Camarosa' seedstock in Canada and the United States. The land rental agreement was finalized with Purcell Farms for twelve acres of land including use of the pivot and fifteen inches of irrigation water.

The remainder of this chronology of SSPP's activities in 2000 is presented below in point form since extensive details can be found in succeeding sections of the study.

Last Half of April 2000

- lay out field
- soil test, calculate fertilizer requirements and purchase fertilizer
- rent strawberry planter from university and transport it to field
- double disk field three times
- prepare irrigation system
- April 30 - begin planting and irrigating
- apply fertilizer with planter
- planting carried out by partners and hired workers

May 2000

- May 7 - finish planting
- irrigate as needed depending on soil moisture conditions; almost daily to encourage rapid establishment of the plants
- invoice California customers and request 10% deposit on plants ordered
- end of May - establish baselines for weeding requirements and pay rates

June 2000

- irrigate as needed; less frequently than in May because of rains.
- weed grassy weeds intermittently throughout month using hourly paid workers
- June 3 to June 8 - weed entire 10 acres – about 20 individuals employed on a contract basis to hand hoe in row and rototill between rows
- June 27 and 28 – top-dress plants with granular fertilizer

July 2000

- July 3 to 21 – rototill, hand weed, deblossom and remove fruit, set runners on entire 10 acres
- July 13 – first inspection by Canadian Food Inspection Agency (CFIA) and University of Saskatchewan horticultural specialists
- July 20 – first inspection by Saskatchewan Agriculture and Food (SAF) small fruit specialist
- July 21 – second fertilization
- end of July - begin arrangements for processing facility and supplies, refrigerated storage, transport for harvested produce and processing employees
- irrigate throughout month regularly to keep surface of soil moist and encourage rooting of runners

August 2000

- correspond with California Department of Food and Agriculture (CDFA) regarding inspection requirements
- August 3 to 17 – third hand weeding of entire ten acres; runner setting
- August 11 – lease processing facility in Saskatoon for September/October
- August 17 – fertilize every other row (half of field) for third time for comparison purposes
- August 30 – collect and submit root samples for nematode testing according to California protocol: CFIA, SAF and university specialists observe procedure

- irrigate throughout month regularly to keep surface of soil moist and encourage rooting of runners

September 2000

- regular irrigation to September 20 to promote plant rooting
- correspond with CDFA and CFIA re: nematode tests, inspection and plant movement
- September 15 to 16 – spot weed and rototill entire ten acres
- September 17 to 18 – meet with California growers for tour of field and university plots
- September 18 – order shipping boxes and plastic liners; rent refrigerated vans for storage
- September 20 – CFIA field inspection; dig 500 plants for early shipment to California customer
- September 22 – SAF and university specialists inspect field
- September 24 – target date for beginning harvest; however, samples test positive for nematodes
- September 24 to 30 – delay harvest, wait for results of second nematode test to better identify nematodes found in the first test
- September 22 to 30 – prepare machinery and processing shed for harvest; arrange to hire processing workers
- September 29 – begin to harvest after second nematode test shows that nematodes are not as serious a problem as at first thought

October 2000

- October 1 to 7 – harvest and process plants; only seven of ten acres harvested because of delay caused by nematode issue
- October 3 to 6 – heavy frosts further hamper harvest activities and potentially damage plants
- October 8 – loaded truck leaves for California
- October 9 - Gary Storey leaves for California to troubleshoot inspection, delivery and planting at customers' sites
- October 11 – truck unloads in California; discovery of harvest, processing or shipping damage to some plants; customers plant only a portion of their plants or remove some they have planted
- October 12- 31 – wind down field and processing activity; pay workers, machine rental charges and other outstanding bills

November 2000 to March 2001

- negotiate adjusted payments with customers because of damaged plants
- monitor progress of plants through regular telephone conversations with customers

March 2001 to present

- continue to monitor development of plants in California
- maintain relations with customers
- maintain production license agreement with University of California

SSPP was originally set up under a one-year partnership agreement. Production was not resumed in 2001 because of:

- financial losses sustained for a number of reasons, primarily:
  - incomplete harvest and low production of marketable product;
  - high per unit production costs, especially labour costs during processing; and,
  - plant damage sustained during harvest, processing, storage and/or transportation;
- uncertainty about regulatory issues; and
- uncertainty about labour availability and quality.

In addition, the yield results from University of Saskatchewan trials carried out in California in 1999/2000 and 2000/2001 and the yield results from the SSPP plants in 2000/2001 were not as positive as the research results from earlier years. Given SSPP's financial losses in 2000 and the lack of sufficient fruit production data from California at the time it was necessary to commit to production in Saskatchewan in 2001, the SSPP partners decided to not produce any plants in 2001. However, the interest that most of the California customers express in continuing to test plants from Saskatchewan may lead to SSPP production in future years.

Section 3. Technical and Financial Analysis of SSPP's 2000 Operations

This section examines in detail the entire production process undertaken by SSPP in the year 2000. It describes the major production activities of SSPP and their costs, comparing and contrasting the actual results with the projected results of the base scenario for Saskatchewan strawberry crown production presented in *Study 2*. Tables placed throughout this section compare the estimates made in *Study 2* with the results of SSPP's first year of operation. This process of comparison identifies the strengths and weaknesses of the assumptions that were made in *Study 2* in the absence of production information specific to Saskatchewan. The results provide a clearer picture of the potential for profitable production of strawberry plants in Saskatchewan for the southern California market. Prospective growers can use this information to analyze the suitability of their own situations for undertaking production.

3.1. Original Budget Estimates vs. SSPP's Actual Expenses and Revenues

Table 3.1 presents the original budget estimates used as a basis for the operation of SSPP in 2000 and the financial results of SSPP's first year of operation. The original budget estimates were developed from the production and financial information provided in *Study 2*, adjusted for the smaller size of SSPP's proposed operation and the fact that SSPP did not plan any capital purchases. SSPP did not harvest all of the plants that it had available in the field in 2000. It also wasted a quantity of plants during processing because of inexperience and inadequate or inappropriate machinery. The *Adjusted Expenses* column reflects the fact that SSPP's costs would have risen if more plants had been harvested, but at a decreasing rate as worker and management efficiency improved with experience. The high costs incurred during the initial processing, as well as during other parts of the production year, meant that the breakeven number of marketed plants would have had to be close to one million plants or ten daughters per mother plant, much higher than the 675,000 plants estimated originally. As explained in the following

sections, there are relatively simple ways to reduce some of the high costs that were incurred in 2000 while the reduction of other costs could be problematic. However, the researchers believe that the original budget estimate could be achievable with the experience gained in 2000.

Table 3.1. Estimated and Actual Expenses and Revenues, SSPP 2000.

*Expense Item**	*Preliminary Budget (C$)*	*Actual Expenses (C$)*	*Adjusted Expenses (C$)****
Mother Plants	8,800.00	7,804.00	7,804.00
Land Rent	4,000.00	3,300.00	3,300.00
Extra Irrigation Expense	200.00	1,620.00	1,620.00
Fertilizer	1,100.00	955.00	955.00
Labour & Management	50,000.00	64,421.00	84,920.00
- Operator Wages		*6,070.00*	*7,100.00*
- Employee Benefits		*541.00*	*625.00*
- Contract Weeding		*16,845.00*	*16,845.00*
- Trimming		*14,112.00*	*30,000.00*
- Workers Comp.		*963.00*	*1,350.00*
- Management		*17,140.00*	*19,000.00*
- Partner Contribution		*8,750.00*	*10,000.00*
Truck Lease	1,750.00	600.00	600.00
Fuel and Repairs	500.00	2,878.00	3,500.00
Custom Work	250.00	0.00	0.00
Machine Rental	800.00	4,361.00	6,100.00
Reefer Rental	3,000.00	900.00	1,350.00
Building Rental	2,000.00	1,000.00	1,000.00
Telephone and Office	1,000.00	915.00	1,200.00
Inspection	500.00	1,215.00	1,600.00
Shipping	6,400.00	5,522.00	5,700.00
Travel	10,500.00	4,396.00	4,400.00
Insurance	0.00	1,100.00	1,100.00
Business License	0.00	110.00	110.00
Bank Charges	0.00	200.00	200.00
Miscellaneous**	0.00	1,911.00	2,200.00
Total Expenses	**$90,800.00**	**$103,214.00**	**$127,659.00**
Actual # Plants Shipped		305,000	
Actual # Plants Sold		220,000	
Gross Revenue		**$30,000.00**	
Breakeven plant # @ US $0.09/plant (C $0.135/plant)	Approx. 675,000 plants		Approx. 945,000 plants

Source: SSPP.

*Some of the expense items and expense sub-totals presented in this table do not exactly correspond to the figures as presented in later tables where some expenses are assigned to different categories to facilitate explanation.

**Miscellaneous includes hand tools, portable toilet rental, gloves, drinks and snacks for workers, advertising for workers, and soil testing among other small expenses.

***In this budget, estimates are made of the increased costs that would have been incurred if harvest and processing had been carried out over two weeks as originally planned, rather than the one week that occurred and if the rate of processing (plant processed per worker per hour) had doubled in the last week as worker and management skills increased.

3.2. General Production Parameters

Section 3.2 discusses the general production parameters for SSPP's strawberry plant production in 2000. Table 3.2 compares some of these basic production parameters with the base scenario presented in *Study 2*.

Table 3.2. General Production Parameters: *Study 2* vs. SSPP 2000.

Production Parameter	*Study 2*	SSPP 2000
Production Acreage	65 acres	10 acres
Budgeted Production (breakeven)	5.2 million plants	675,000 plants
Budgeted Production/acre	80,000 plants	67,500 plants
Land Tenure	rented production acres; owned machinery; farmstead and processing facilities	rented production acres, machinery and processing facilities
Production Location	Outlook area	Pike Lake area
Processing Location	farmstead in Outlook area	Saskatoon
Distance: Production – Processing	0-20 kilometres	45 kilometres
Soil Quality	sandy loam	loam – variable from clay to sand
Cost of Land and Water	$250/acre	$275/acre for 12 acres $330/production acre (10 acres)
Irrigation System	pivot – grid electricity; water from irrigation district	pivot – diesel-generated electricity; water from river
Extra Irrigation Expense	$15/acre pivot electricity	$162/acre pump location costs

Source: *Study 2 and* SSPP

3.2.1. Scope of Enterprise

Study 2 presented a cost of production analysis for a sixty-five acre operation that owned buildings, machinery and ten-acre farmstead. *Study 2* assumed that the production location changed annually, using rented irrigated land where pivot and water were supplied by the landowner. SSPP's production in 2000 was much smaller and was structured on a more temporary basis with ten acres in production and no machinery, buildings or land purchased. There were no capital expenditures made, except for a small investment in hand tools. The production land tenure arrangements were similar to those used in *Study 2* - cash rent on a per acre basis with irrigation water and pivot supplied by the landlord.

The sixty-five acre operation described in *Study 2* was assumed to be economical in size and scale, although it was noted that the costs of owning the specified mix of buildings,

machinery and land might be onerous if used for the sole purpose of producing strawberry plants. Strawberry plant producers in Eastern Canada of this size often are involved in other nursery or fruit production enterprises that make use of some of the same capital items, thereby reducing ownership costs.

The small scale of production undertaken by SSPP had some operational and financial implications. Ten acres of production was chosen for a first attempt because it was considered to be large enough that the requirements for commercial production would be present, including the potential to make a profit. Fruit grower customers in southern California had indicated a desire to grow enough Saskatchewan plants to do extensive field tests. They were willing to purchase enough plants to consume the production of ten acres, if plant yields turned out to be at about the mid-point of experimental yields.

SSPP limited the size to ten acres in recognition of the physical demands of large-scale intensive horticultural production. Financial exposure at this size also was limited to a level that the partners felt was reasonable given the risks involved in a new and unproven venture. There were, however, returns to size and scale indicated in *Study 2* that were not captured at the ten acre size, especially in terms of management, marketing and transportation costs. These increased per unit costs are identified in the appropriate places in the following analysis.

In other respects, ten acres may have been too ambitious an undertaking in the first year of production. For example, large weeding crews were required to control weeds since no herbicides are used in the production of strawberry plants. These crews also had to deblossom plants and hand set runners. Some difficulties were experienced in finding and keeping enough competent field labour and using it efficiently. The cost of field labour ended up well above the budgeted amount because of labour quantity and productivity issues, because of inefficiencies in the use of the labour caused by the physical layout of the field, and because of the learning curve undergone by management in terms of both labour and agronomic management. A smaller acreage could have been more tightly managed.

While there were some problems managing ten acres of field production, it was the processing of the volume of plants from ten acres that was most difficult. Harvest had been planned for a two-week period at the end of September and the beginning of October to meet the requirements of the California customers. Assembling and training the labour to complete harvest and processing within this period and within the budgeted cost had been recognized as the most difficult hurdle to clear in the whole production process. This already compressed time period was halved after nematodes were discovered in root samples, requiring further identification which delayed the start of harvest by one week. The harvest period could not be extended at the other end because of planting constraints in California.[9] Finding enough competent labour for such a compressed period and employing it efficiently proved to be very difficult. Changes to management techniques, financial incentives and the physical process that could have been implemented over a two-week period to increase efficiency could not easily be made in the shorter time period. Weather and machinery problems compounded the difficulties. It became a struggle to keep enough workers of any type, let alone skilled workers, to fill orders at the bare minimum level. As a result, labour productivity was very low. The output of processed product was low and the cost of labour per plant trimmed was much higher than budgeted.

It could be argued that the problems outlined above could not be factored into the original decision on production size. However, agricultural production is always unpredictable, especially in the initial years of production, and the potential for unforeseen problems should have suggested a smaller first year operation.

3.2.2. Production Process and Timeline

The production process and timeline followed by SSPP in 2000 is outlined in Section 2. It very closely replicated the outline of the production process presented in Table 3.1 of

[9] Most of the California customers had essentially finished planting when the SSPP plants arrived on October 11, 2000 and had begun to lay-off their planting crews.

Study 2. SSPP finished planting in the first week in May, earlier than anticipated in *Study 2*. It should be possible to plant even earlier than this in future years, which might extend the rooting period for daughter plants before harvest. Strawberry fruit growers in Saskatchewan are known to try to plant in the last half of April if soil conditions are suitable. Harvest began on October 1, later than the mid-September date estimated in *Study 2,* because of the necessity for extended testing for nematodes after their presence was discovered. (This issue is discussed in detail in Sections 4 and 5.) The ability to begin harvest in the middle of September or even earlier will be a key to capturing the southern California market since many fruit growers there want to advance planting to this time if adequately-chilled plants can be found. At the present time such plants are not available from the California nurseries, largely because of lack of chilling.

3.2.3. Location of Production and Processing

Study 2 recommended the Outlook irrigation area as having good potential for a strawberry plant production operation because its climate, irrigation infrastructure, suitable soil, and fairly close proximity to a pool of labour in Saskatoon. SSPP, however, rented land from Purcell Farms about forty-five kilometres from Saskatoon south of Pike Lake on the west bank of the South Saskatchewan River. This location was chosen over the Outlook region because of its closer proximity to the partners' homes, to the university and to labour available in Saskatoon (about one half the distance that Outlook is from Saskatoon). One partner lived within twenty kilometres of the site while the rest lived in Saskatoon. In addition, the owners of the land had available most of the machinery required to run the operation including a mint harvester that, with modification, could be used as a strawberry plant harvester.

Land negotiations occurred in the winter because of the late start to production planning, so there was little opportunity to assess land quality and variability or potential weed and pest problems. The search for land should ideally have taken place at least the previous summer so that detailed observations could be made of these characteristics. *Study 2* suggested that a strawberry plant operation in Saskatchewan should move production

continually to new land to avoid any disease or pest problems. Over time, an established producer could secure land several years in advance of production. More control could then be exercised in preparing it for plant production in terms of crop rotations, weed and pest control and soil preparation.

SSPP processed the harvested plants in a rented building on 11th Street West in Saskatoon. Other locations that were considered were a building available at the landlord's farmstead about ten kilometres from the strawberry field and the Vanscoy arena, about thirty-five kilometres away from the field. The decision to process in Saskatoon was made mostly because access to labour was the biggest constraint in the harvesting process. Transporting the plants forty-five kilometres into Saskatoon was easier than moving labour the other direction. Being in Saskatoon during processing was also easier in terms of attending to business affairs such as purchase of supplies and arranging inspection and transportation to California.

3.2.4. Climate

It is still not clearly understood what effect climate variations have on the development of northern vigour in strawberry plants grown in various locations in the province. The number of chilling hours (hours with temperatures between 0 and 7°C) accumulated in August and September is used as a measure of the readiness of strawberry plants for harvest. Southern California fruit growers carefully watch the progress of chilling in the high elevation strawberry nurseries of northern California as an indication of when plants will be ready for harvest and the quality of the plants. Their interest in Saskatchewan plants is partly based on the hope that chilling hours here will consistently accumulate early, allowing for an early harvest and, thus, early plant availability. While chilling requirements vary by cultivar, plants are commonly thought to require 200 hours or more of chilling to initiate optimal numbers of floral buds. However, 'Camarosa' plants multiplied in Saskatchewan have sometimes performed better in tests in California in years when the number of chilling hours has been significantly lower. Krieger and Tanino (November 2000) suggest that 'Camarosa' may have a lower chilling hour

requirement than some other varieties because it was bred for mild climates. It is possible that over-exposure to chilling temperatures might, in fact, be detrimental to 'Camarosa' crowns.

Although the Pike Lake land is within a few kilometres of the northern edge of the Outlook irrigation district, the climate appears to differ between the two areas based on data collected in 2000. Temperature data was collected by university researchers at both the Outlook and the Pike Lake locations. The profile of temperatures was quite different at the two locations for the months of August and September which is the time when chilling hours are accumulating prior to harvest. As shown in Table 3.2, there were no chilling hours at the Outlook location in August 2000 while there were 36 hours at the Pike Lake location. There were only 111 chilling hours during September at Outlook with only 15 of them in the first half of the month. There were 190 chilling hours at Pike Lake in September, including 61 hours in the first half of the month. According to the usual understanding of the importance of chilling hours, the Pike Lake plants had adequate chilling before the end of September, while the Outlook plants were deficient in accumulated chilling hours. However, the significance of this difference is not known because of the uncertainty surrounding the chilling requirements for 'Camarosa'. Further research in this area is important for a Saskatchewan plant production industry before commitments are made to a production location.

The effect of frost early in the fall and the probability of hard frosts in September and early October will also be important issues in the future location of strawberry plant production in Saskatchewan. Fruit yields have been shown to decrease in some varieties when crowns are exposed to temperatures of –8°C for two hours (Nestby and Bjorgum 1999). Hard frosts experienced in early October 2000 at Pike Lake during harvest appear to have heavily damaged SSPP's production. This issue is discussed in detail in Section 3.3.1.c. and Section 4.

Table 3.3 shows that there were no hours below freezing in September at Outlook, while there were 15 hours below freezing at Pike Lake in that month. In the first six days of

October, during the SSPP harvest, there were 85 hours when the temperature was below freezing at Pike Lake, including 11 hours below –8°C. There was also frost in Outlook on five of the first six days in October with temperatures dropping to –8.1°C and –8.4°C on October 5 and 6.

Table 3.3. Chilling and Freezing Hours, Fall 2000: Outlook and Pike Lake.

	Outlook	Pike Lake
Chilling* and Freezing Periods	***# Hours***	***# Hours***
August Chilling Hours	0	36
September 1–15 Chilling Hours	15	61
Total September Chilling Hours	111	190
Total Chilling Hours: August/September	**111**	**226**
August Freezing Hours	0	0
September Freezing Hours	0	15
October 1-6 Freezing Hours	n/a	85
Total Freezing Hours: August 1- October 6	**n/a**	**100**
October 1-6 Hours Below –8°C	**n/a**	**11**

Source: Krieger and Tanino (November 2000) and unpublished.
*Chilling hours are defined as hours where the air temperature is between 0 and +7 degrees C.

3.2.5. Cost of Land and Water

Twelve acres of land were rented from Purcell Farms for one year at a cost of $275 per acre for the land, the use of the pivot as needed and fifteen inches of irrigation water. Two extra acres were rented over the ten needed for production to provide research space for Dr. Tanino's northern vigour project and to separate the strawberry plants from the surrounding durum field. The cost of renting these extra acres increased the rental cost to $330 per acre for the ten acres in production. Another $1,620 was spent on custom work to place the irrigation pump in a position along the riverbank that would increase the ability to pump even when the river was low. This extra charge ($162 per acre) must be considered part of the cost of securing land and water. Therefore, land and water cost SSPP $492 per productive acre in 2000.

This rental price is very high when compared with the rental cost for irrigation land in the Outlook irrigation district of $175 to $250 per acre. It reflects the high cost of providing water outside an irrigation district, the short time period available to find land, the

willingness of SSPP to pay for convenient access, and the inconvenience to the owner of renting out a small amount of land in the middle of a large field.

3.2.6. Land Description and Soil Type

The land is situated within two hundred metres of the South Saskatchewan River on a river flat about twenty feet above the river level. It is fairly flat with a low spot through the middle and gentle slopes on both the east and west sides at the south end.

A sandy loam is probably the best soil in which to grow strawberry plants to provide some fertility and water-holding capacity through the growing season while ensuring that the soil can be easily removed from the plant roots at harvest. The soil at the Pike Lake location is rated as a loam, but there is quite a wide variability, from dune sand with very little fertility or water-holding capacity to soils with some clay in the low spot. The pH of 8.3 is higher than recommended for strawberry production. It should have been possible to rent more uniform and higher quality land within the irrigation district at Outlook or in another suitable location at a lower price, if there had been more time to search.

3.2.7. Irrigation System

Irrigation was provided by an 1,100 foot pivot that moved 180 degrees across about one hundred acres of land. The twelve rented acres were located near the edge of the field where the pivot was usually stored so that the strawberry plants could easily be watered more frequently than the rest of the field. The strawberry field was laid out in a pattern of decreasing rows that matched the movement of the pivot, so strawberry watering did not overlap onto the durum crop.

The Purcell land is not within an irrigation district and the pivot is not connected to the electrical grid. The costs of operating a diesel pump to produce electricity are high and access to water is not guaranteed, given a constantly fluctuating river. The high cost of

providing water was reflected in high land rental costs and in the additional charge by the landowners to locate the pump in an optimal location.

The high soil pH combined with the high pH of the river water was a potential problem in terms of causing chlorosis, but after some initial concerns this did not appear to be a major problem. There were several occasions when the river was too low to use for irrigation or that the pivot broke down just when it was important to water in order to encourage rooting and root development in the daughter plants. There is no doubt that there was some loss of marketable yield of daughter plants because of lack of, or poor, root development, although an estimate is not possible without specific research into this issue.

It is very important to clearly negotiate the terms of any irrigation agreement, since the actual demand for water is not known at the beginning of the season. Strawberry plants must be watered not only well but frequently so that the surface of the soil remains moist, especially during rooting of the daughter plants. Because this requirement for frequent watering was not completely understood by the landlords, they were unhappy about the wear and tear on the pivot equipment from the frequency of watering. From SSPP's point of view, there were times when the pivot should have been run but watering was delayed because of this underlying tension between SSPP and landlord. From the landlord's perspective, the frequency of watering put an unacceptable strain on the irrigation equipment.

3.3. Critical Production Variables

Study 2 identified the four variables that were felt to likely have the most impact on the profitability of strawberry plant production in Saskatchewan (*Study 2*, Section 4). These were:

- the price received for crowns (daughter plants);

- the number of crowns produced per mother plant;
- the number of crowns trimmed per worker per day during processing; and,
- the overall cost of labour to produce and process the crowns.

The price of US $0.09 per plant received by SSPP in 2000 is discussed in detail in Section 4. The following discussion focuses on the other three critical variables and the relationship of the various production and processing activities to them. The number of crowns trimmed per worker per day is discussed as part of the larger analysis of cost and efficiency of labour in the production and processing of strawberry crowns (Section 3.3.2).

3.3.1. Number of Daughter Plants (Crowns) Produced and Marketed

Based on the results of *Study 2*, SSPP's preliminary budget suggested that production of 675,000 marketable plants (6.75 daughter plants per mother plant) on ten acres, marketed at US $0.09 per plant would cover costs estimated at about C $91,000. In fact, in 2000, sales would have had to be nearly one million plants from ten acres to break even, given the larger than expected expenses, especially during processing. SSPP processed and shipped only 305,000 plants (less than half of the budgeted amount) and received payment for only 220,000 plants because of plant losses in the fruit fields. Table 3.4 provides a summary of SSPP's expected and actual production of plants in 2000 and compares these results with the estimates from *Study 2*.

Table 3.4. Plant Production, Plant Price and Gross Revenue per acre: *Study 2* vs. SSPP 2000.

	Study 2		SSPP 2000					
Plant Measure	Budgeted Plants/Acre (breakeven)	Daughters/ Mother Plant (budgeted)	Budgeted Plants/Acre (breakeven)	Daughters/ Mother Plant (budgeted)	Actual Plants/Acre (based on 10 acres of total production)	Daughters/ Mother Plant (actual)	Actual Plants/Acre (based on 7 acres harvested)	Daughters/ Mother Plant (actual)
Mother Plants	10,000	-	10,000	-	10,000	-	10,000	-
Daughter Plants in Field	80,000+	8+	67,500+	6.75+	80,000+ (est.)	8+	80,000+ (est.)	8+
Marketable Daughter Plants in Field	80,000+	8+	67,500+	6.75+	61,500+ (est.)	6.15+	61,500+ (est.)	6.15+
Plants Shipped	80,000	8	67,500	6.75	30,500 (actual)	3.05	43,570 (actual)	4.36
Plants Sold	80,000	8	67,500	6.75	22,000 (actual)	2.20	31,430 (actual)	3.14
Selling Price/Plant	US $0.07	-	US $0.09	-	US $0.09	-	US $0.09	-
Gross Revenue/Acre*	US $5,600 C $8,400	-	US $6,075 C $9,112	-	US $1,980 C $2,970	-	US $2,830 C $4,245	-

Source: *Study 2* and SSPP.
*Exchange rate used of C $1.50:US $1.00

From a profit-making perspective in 2000, the SSPP partnership was not financially successful. However, SSPP's plant production in 2000 must be evaluated in a number of ways in order to develop a perspective on the potential for profitable crown production in Saskatchewan in future years. These include:

- the total number of marketable daughter plants in the field before harvest. Given some of the production problems encountered in 2000 because of inexperience (described throughout this chapter), production methods can be improved over time to ensure that more daughter plants are produced per mother plant and that more of them grow to a sufficient size and develop enough roots to be marketable.

- the number of plants shipped. This number can differ from the number of marketable plants in the field, as it did in 2000 for SSPP. A difference between the number of plants processed and shipped and the number of marketable plants in the field indicates some breakdown in the harvesting, transportation, or storage of untrimmed plants or in the processing operation.

- the number of plants actually purchased by customers. A difference between the number of plants shipped and the number actually sold indicates a breakdown in the production, processing or shipping systems, regulatory problems or customer dissatisfaction for other reasons.

3.3.1.a. What is a Marketable Strawberry Plant?

Profitably producing and selling strawberry crowns (daughter plants) is the objective of a strawberry plant multiplication business. Maximizing the production of marketable daughter plants per mother plant within economic constraints is one of the major components of profitable production.

Strawberry plants can produce large numbers of runners and daughter plants. However, only some of these daughter plants take root or have large enough crowns or enough root

development to be marketable by the time it is necessary to harvest them. The number of marketable crowns produced per mother plant over the course of research in Saskatchewan has been low. The short growing season and rigorous climate in Saskatchewan probably limit the multiplication rate here relative to other plant production areas such as eastern Canada and northern California. In addition, the target market in southern California demands that plants be dug early. This means that a lower percentage of the total daughter plants produced are able to reach a marketable size than if the plants were left in the ground longer.

In eastern Canada, multiplication rates are commonly twenty marketable daughters per mother plant and sometimes reach forty daughters per mother. In California, the multiplication rate can be even higher. The numbers of marketable daughter plants per mother plant in Saskatchewan tests have tended to be in the four to seven range, although tests at Outlook in 2000 produced eleven rooted daughters of marketable size per mother plant (Krieger and Tanino, December 2000). However, Saskatchewan plants should be able to produce more marketable daughter plants than these numbers indicate. Management techniques need to be improved to ensure that a larger percentage of the daughter plants that are produced take root and root early enough to reach marketable size. Improving both the total multiplication rate and the percentage of marketable plants must be central to efforts to create a plant production industry in the province.

There is no objective standard as to what constitutes a marketable crown. Buyers and sellers must come to an agreement as to what is acceptable. Established plant producers are aware of the minimum plant size and minimum root development that customers will accept. They are also aware of the quality and size of plants that their competitors are selling. Customers (fruit producers) want large crowns with well-developed roots, although research does not necessarily support the superiority of such plants. Plant producers want to sell as many of their plants as possible, so are likely to try to include some plants that are smaller and less developed than customers would like.[10] The

[10]In a conversation with the authors, a leading Nova Scotia plant producer expressed concern that Florida customers are demanding larger crowns with more root development each year and that plants that were

acceptable minimum plant probably varies from year to year with variations in the growing conditions in the nurseries and in the numbers of plants available for sale. There is an upper limit to acceptable plant size also, since very large plants become difficult to handle in the planting process.

The issue of what is a marketable plant proved to be a difficulty for SSPP in 2000. California customers who visited the SSPP production site in September 2000 picked plants that had crowns as least as big in diameter as a pencil and roots several inches long with many hair roots as their minimum examples of what they were willing to accept. This standard eliminated a large percentage of the rooted plants in the field, since rooting had occurred quite late for many plants.

As a result of striving to meet the requirements set out by the California customers, large numbers of crowns were culled during the SSPP processing operation. During his visit to the California customers in October 2000, Dr. Gary Storey compared SSPP's product with plants from one California nursery. He estimated that 30% of the plants provided by this California nursery were smaller than the smallest plants that SSPP had provided. In other words, SSPP may have discarded 30% of its marketable plants and this was in a year when the California plants were the best that the customers had seen in many years.

Storey observed that southern California fruit growers will plant almost everything that the nurseries send them. The planting crews do not seem to pay close attention to the quality of the plants. The test of nursery material is whether it lives through the establishment process after planting. For this reason, root development may be more important than crown size in nursery plants, although crown size could be related to northern vigour.

In order to address this issue in future years, Saskatchewan plant producers will have to spend time and effort establishing on an annual basis what is the minimum acceptable

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acceptable in past years must now be discarded during processing. Another Nova Scotia plant producer is catering to the demand by only selling large plants. Other Nova Scotia producers are unhappy with this

size and development. This decision must not only be based on the customers' stated preferences, but also on information gathered from other nurseries. In retrospect, SSPP should have ordered plants as early as possible in September 2000 from more than one California nursery to establish the range of size and quality shipped.

Shipping as small plants as possible, however, may not be in Saskatchewan producers' best interests. Some portion of the northern vigour exhibited by Saskatchewan plants may occur because daughter plants sent to California have been carefully chosen for their large size and good root development in past years. The vigour may also partly occur because of the high percentage of primary daughters that are present, given the low multiplication rates. It is possible that Saskatchewan plants may have to be larger on average than California plants and may have to come from a smaller pool of plants (fewer secondary and tertiary crowns) to maintain a competitive edge and command a premium price.

Chas Nakama, an SSPP customer from Oxnard, California and a long-time cooperator with the Saskatchewan research had agreed to help carry out research on the productivity of small plants versus larger plants in 2000. Several boxes of culled SSPP plants were sent to him along with the rest of his shipment in October 2000. These were to be planted for comparison with the larger plants. Unfortunately, these plants did not arrive in good condition and were not planted. Their poor condition may be related to the fact that, because of their size, it took much longer to fill a box with them. Therefore, they may have been exposed to warm, dry conditions longer than other plants. In addition, they may have filled the boxes more densely than larger plants and, thus, taken longer to cool down when placed in refrigeration, leading to deterioration in the boxes.

3.3.1.b. Field Production of Marketable Strawberry Plants

There was no accurate estimate made of the total number of daughter plants, both rooted and unrooted, produced on runners in the SSPP field in 2000. Counts of rooted plants taken throughout the field in September 2000 indicated that there were between 800,000

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sales strategy because they think it accelerates the demand for larger plants.

and 1,000,000 plants that had rooted in the ten acre field, or about eight to ten rooted daughter plants per mother plant. However, rooting occurred quite late for many of these plants so the amount of root growth was not sufficient to make a marketable plant according to the specifications given by California customers. There was also a large number of daughters that had not established roots. Unfortunately, some of these were primary daughters that should have been the largest and most well-established plants. Possible reasons for this lack of rooting among the primary daughters are lack of moisture at the soil surface or disturbance by weeding crews at a critical rooting time.

The number of marketable plants in the field in 2000 can be estimated from the total number packed and shipped (305,000), adjusted for several factors. First, only seven acres were harvested out of the ten available for harvest. If yields are considered to have been even across the field (both the lowest and highest yielding areas were harvested), the marketable plants on ten acres should have been at least 435,000 plants. In addition, SSPP may have been culling as many as 30% of marketable plants, increasing the total to 565,000 marketable plants. Approximately 50,000 plants must be added to this total to account for a harvested truckload that was not processed because the deadline for the truck to leave for California had been reached. There was also some other loss in the transfer of plants from field to processing table. Thus, total marketable plants in the field can be estimated at 615,000 plants or more (6.15 daughters per mother plant), somewhat less than the original budget target of 675,000 plants.

More than six marketable daughter plants per mother plant cannot be considered a complete failure in the first year of production, given the variation in production at different locations in Saskatchewan over the years of research. *Study 2* estimated that at least eight daughters per mother would be necessary for profitable production in Saskatchewan, but the price received by SSPP in 2000 was significantly higher than that projected in *Study 2* (US $0.09 per plant versus US $0.07). However, given the high costs of production experienced by SSPP, the production process will have to improve so that a higher percentage of daughter plants grow to a marketable size.

There are many possible reasons for the low number of well-rooted daughter plants. Several factors that are thought to have adversely affected production in SSPP's first year of operation are discussed below.

Soil Quality and Fertility

The soil quality at Pike Lake was more variable than had been expected when the land was rented. One sizeable area comprising as much as 10% of the total area was basically dune sand with very low fertility and water-holding capability. Mother plants were smaller and had fewer runners in this area and it was difficult to keep the surface damp to allow rooting of the daughters. Another area had higher levels of clay than expected. While the fertility seemed to be adequate in this area, the surface of the soil became hard when dry, making rooting difficult.

Soil testing was carried out prior to planting. The pH of the soil was 8.3, which is higher than recommended for strawberry production and can affect nitrogen uptake. The soil was rated as non-saline. Table 3.5 presents the fertilizer regime for SSPP in 2000. The soil test called for the addition of about 87 lb/acre of N and 113 lb/acre of P. Sulphur was added at the recommendation of an experienced strawberry producer. 220 lb/acre of 17-20-0-15 granular fertilizer were side-banded at planting time (37 lb/acre N, 44 lb/acre P and 33 lb/acre S). Since this was side-banded in a narrow strip along the plants, the concentration in the area of the plants should have more than fulfilled the test recommendations.

Table 3.5. Fertilizer Regime, SSPP 2000.

Date of Application	Fertilizer	Method of Application	Total Product lb/acre	N lb/acre	P lb/acre	S lb/acre
May 1-7	17-20-0-15	Sideband	220	37	44	54
June 27	20-0-0-24	Hand Spreader	325	65	-	78
July 21	20-0-0-24	Hand Spreader	325	65	-	78
August 17	20-0-0-24	Hand Spreader (half of acreage)	175	35	-	42

Source: SSPP.

SSPP top-dressed the plants during the growing season because their pale green colour in June indicated nutrient deficiency and because it is thought that high nitrogen rates may increase the number of runners (Alberta). Therefore, on June 27 and July 21, 2000, granular 20-0-0-24 was spread on the rows and the rooting area between the double rows, which comprised about six acres in total. The rate of application was about 65 lb/acre of N each time. On August 17, every other double row received about 35 lb/acre of N, using granular 20-0-0-24. This procedure was carried out to test if there was any different response by the plants in the adjoining rows. Visually, there was no difference noted between rows that received the late fertilization and those that did not. No rooted plant counts or other tests were carried out to gather more information on the effect of this fertilization.

Planting Timing, Density and Configuration

Planting took place in the first week of May. Planting could have been earlier in terms of climatic conditions, since strawberry plants have some ability to withstand spring frosts. However, watering at planting time is essential and the irrigation system was not operational. Earlier planting, while it may not encourage earlier runnering, should produce larger and more vigorous mother plants by the time they run, hopefully contributing to the production of more developed and larger numbers of daughter plants.

There were areas of the field that had not been worked deeply enough prior to planting. In these areas, the roots of the mother plants were not placed well even with hand setting. Although survival of mother plants was almost 100%, some of the plants may have struggled because of their poor start with a resulting reduction in plant production.

SSPP followed the 10,000 plant per acre planting rate that the previous experimental work in Saskatchewan has used. This planting rate is also found on some of the strawberry plant production enterprises in Nova Scotia. Other operations in the Maritimes plant only 5,000 plants per acre. In Ontario, strawberry plant producers plant as many as 12,000 to 14,000 plants per acre.

The planting and cultivation pattern used in 2000 was a mix of planting styles that may have to be adjusted in future years. The Nova Scotia farms that plant 10,000 plants per acre allow the subsequent runners to cover the entire field. The farms that plant 5,000 plants per acre cultivate in between the rows and sweep the runners into a thick row, using perhaps sixty per cent of the field for production.

Because of the design of the mint harvester that was to be employed for harvesting, the planting style chosen by SSPP used double rows three feet apart with a five-foot space between each set of double rows. Plants were set about one foot apart within the rows. The runners were allowed to fill the three foot space within the double rows and expand out to a double row width of five feet. This was the maximum width that the harvester could dig in one pass. This configuration allowed mechanical weed control (rototiller) between the sets of double rows throughout the season but only about 60% of the available land was used for crown production, or about six acres. It may be that this was too crowded, restricting the production of large well-rooted daughter plants.

The California customers who visited in September 2000 were surprised that so little of the available space was used for runner production. California nurseries allow the daughter plants to fill the entire field and harvest in a circular pattern moving in from the outside of the field so damage to crowns from harvester tires is minimal. Of course, in California space is at a premium because costs of land are extremely high relative to Saskatchewan.

There is still much to be learned about optimum planting densities and planting configurations that maximize the use of land while allowing efficient control of weeds, reducing the amount of hand setting and increasing the effectiveness of the hand setting that must be done. The harvester to be used will have some impact on the planting configuration. The wheel spacing of the mint harvester used in the year 2000 suggested the configuration used by SSPP, although there were other possibilities even with that type of harvester. The planting configuration used by SSPP was not optimal in terms of land use, or hand labour efficiency.

Water Supply

South Saskatchewan river water has a high pH which, when combined with high pH soil, may have had some negative effect on plant vigour and productivity. Although the total amount of water delivered to the plants throughout the season was adequate, the timing was not always optimal. At the time the primary daughters were attempting to root, the frequency of irrigation was not high enough and the surface of the soil dried out between waterings, with the result that many of these plants, although very large by harvest time, never did root. Thus, many large crowns had to be culled during processing for lack of (or no) root development. The top layer of soil was kept damp in the latter part of the season which improved the rate of rooting for smaller, less desirable plants, but by this time it was too late for many of the large plants.

There were several reasons for inadequate watering. There were some poor management decisions and miscommunication with the landlords mostly because no one lived in close proximity to the field. On one occasion, rain was reported over the course of several days at the landlord's home farm about five kilometres away. This rain was thought to be general. It was expected that it would be difficult to access the strawberry land. However, there was actually very little rain on the strawberries and irrigation should have been continued through the period. The landlords expressed concern at times about the wear and tear on their equipment because of the frequency of watering. Although permission to irrigate was never denied, there were times when watering might have been beneficial but was delayed because of this issue. At various times in the season, the irrigation system broke down or the river level was not high enough to pump water. These periods were never lengthy but were long enough to affect the rooting process. In addition, the pivot did not deliver water equally across the field even after time was spent flushing the system and repairing sprinklers.

Pests and Diseases

a. Nematodes

SSPP did not fumigate the soil before planting. Pre-planting soil fumigation is one of the major tools used in strawberry plant production elsewhere for control of soil-borne

nematodes as well as control of weeds, insects and diseases. California nurseries have depended heavily on the efficacy of the fumigant methyl bromide in their operations. However, methyl bromide has been identified as an ozone depleting substance and its use is being phased out by international agreement. Developed countries have already begun to decrease its use and its use is be completely phased out (except for a few exceptions) in developed countries in 2005. The California strawberry industry is funding research into alternatives, but growers are concerned that nothing seems to work quite as well as methyl bromide. Eastern Canadian nurseries use a variety of other fumigants (see of *Study 2,* pp.53-57 for a detailed discussion of fumigants and their costs and benefits).

Because a rigorous climate such as is found in Saskatchewan may have fewer pest problems and because fumigation with methyl bromide is becoming a regulatory issue, producing strawberry plants without fumigation in Saskatchewan has been discussed in the research as a possible competitive advantage. Nematode tests carried out in 1999 on various strawberry plant research plots across the province showed very low levels or no nematodes in the soil or plants. Based on this information and a lack of fumigation equipment and experience, SSPP decided to produce without the use of fumigation in 2000.

In August 2000, SSPP submitted plant samples to the University of Guelph to satisfy California state requirements for the testing for nematodes of plants grown on unfumigated soil. These tests indicated that there were economically significant numbers of the nematode Pratylenchus penetrans present in the SSPP plants in quite large numbers (Appendix A). The unanticipated discovery of nematodes in the SSPP crop proved to be a major regulatory and marketing problem for SSPP in 2000 (see Section 5.2.2.f.). However, it is not known what effect, if any, the presence of these nematodes actually had on the production of daughter plants.

In retrospect, both the soil at the Pike Lake location and the mother plant material purchased from California should have been tested for nematodes before planting

occurred in the spring of 2000 to ensure that neither were a source of infestation. In future years, soil and mother stock should be tested before planting routinely, especially if production occurs without fumigation.

b. Weed Competition

Weeds were fairly successfully controlled throughout the growing season, although there were areas of wild oats and green foxtail that were difficult to keep up with.. The method of weed removal was to use large groups of workers when a flush of weeds seemed to have mostly germinated. The first weeding was carried out in early June by rototilling between all of the rows (there were no runners at that time) and using long-handled hoes within the rows. The major weed at this time was volunteer canola from the previous year's crop.

The second weeding in early July was done with hand rototillers between rows and mostly with short-handled hoes within rows. At this time there was a variety of broadleaved weeds including canola and kochia and a significant amount of green foxtail. In the sandiest area of the field there was an infestation of horsetail and burr.

The third weeding was mostly by hand within the double row area, as plants had started to fill in this area. The area between sets of double rows was rototilled. Red-root pig weed was the major weed present at this time. This weed was difficult to see among the strawberry plants and seedlings were missed even with very careful weeding. There were also some areas with some Canada thistle.

The final weeding in September was carried out to reduce the number of weeds harvested and for cosmetic reasons before the visit of the California customers. Large weeds (mostly red-root pigweed) that had escaped the attention of workers during the previous weeding were removed from the field.

SSPP took a significant risk when it rented land with very little information on the weed populations present. As it turned out, the land was only moderately weedy and weed

control was fairly successful, although more expensive than anticipated. There was some damage to the strawberry plants throughout the weeding season because of rough and inattentive workers and because the removal of large weeds sometimes disturbed or removed nearby strawberry plants. Earlier and more continual removal of weeds by a smaller number of workers hired more regularly may have reduced competition for nutrients and prevented disruption of the rooting process for daughter plants that were in close proximity to large weeds.

c. Disease, Insects, and Animal Pests

No control measures were necessary for insects or disease in 2000. CFIA, SAF and University of Saskatchewan inspectors and specialists found very little insect or disease damage of any type in the SSPP field in 2000. There were a few grasshoppers but they did no obvious damage. There was some deer damage at one end of the field that was near to an area of wild bush. The animals walked and grazed on some plants, but it was not a major problem. Large flocks of cranes landed on the field in September since it was the only green area around, but they did not noticeably damage the plants either.

Runner Setting

Based on SSPP's experience, some effort and expense must be expended in helping daughter plants to set roots. There are a variety of ways that this can be accomplished. Producers in other parts of North America try to do some mechanical setting such as using cultivators to throw soil over the plants. However, hand setting into the soil seems to be required at some point. Inexperience with the amount and quality of runner setting required may have been one of the main mistakes made by SSPP in terms of producing marketable plant numbers.

Because of SSPP's planting configuration where daughter plants grew within the boundaries of double rows, it was not possible to use a cultivator to set plants. Hand setting should have begun with the appearance of the primary daughters since these plants probably have the most value because of their potential size, vigour and ability to produce their own runners. However, hand setting is time consuming and, thus,

expensive so it was hoped that rooting would occur without assistance. Very little early hand setting within the double rows was carried out.

Runners that grew into the cultivated strip between sets of double rows had to be turned back into the double rows in order to keep the width of the double rows narrow enough for the mint harvester to undercut. This runner moving required a large amount of extra hand labour. It also disrupted the rooting process as plants that had grown in one direction and perhaps started to root were lifted and set to grow in another direction. Without actually setting the moved runners into moist ground in the double row, the runners often would not stay in place or, if they did, could not touch the ground to root because they sat on top of the profusion of runners and plants already within the double row. Strawberry daughter plants will not root unless they are in contact with moist soil. Therefore, some of the primary daughter plants never did root although they sent out secondary and even tertiary runners. Many large primary daughter plants were rejected during processing because of little or no root production, while smaller secondary or tertiary daughters were processed. It is important to maximize the number of marketable primary daughters since they may out-bear secondary or tertiary daughters by large amounts, when planted for fruit production, and raise the overall productivity of Saskatchewan plants (Alberta n.d.).

There are a number of methods of runner setting that need to be explored because of the importance of the operation and its high cost if done only by hand. Single rows where the runners are allowed to grow in all directions should likely be used. The primary runners then could be swept back beside the mother plants using a cultivator (always in the same direction). Setting runners should begin early because it is most important to gain the advantage of having large, well-rooted primary daughter plants. It is probably worth using a crew of hand setters to make sure all primary daughters are set into the soil.

As secondary and tertiary runners appear, the cultivation should move further away from the mother plants, but could still sweep the runners into rows alongside the older

runners. At some point the decision would have to be made as to whether the plants should be allowed to cover the entire field or cultivated space should be kept between the rows. If the plants are allowed to cover the field, weed removal will become more difficult and expensive, since only hand weeding will be possible. Planting in very clean fields or being able to use some herbicide such as Treflan will be important to minimize the weed problem. There also will be some loss of plants at harvest from damage by machinery tires. One grower in New Brunswick who lets plants cover the whole field spaces his rows to conform to the width of his machinery and drives on top of the mother plants, cutting the runners off on either side and only harvesting daughter plants. This method could reduce labour and transport requirements during harvest and processing. With other methods of harvest, a great deal of effort is expended on removing harvested mother plants during processing.

SSPP considered applying a thin soil mulch on top of the rooting plants. A small area was done by hand to observe the effect. Although no systematic rooted plant counts were carried out in this area, the majority of plants appeared to be well-rooted. In some places the soil mulch was too thick and the plants struggled to thrive. At one point, preliminary inquiries were made into the use of manure spreaders to spread a soil mulch across the field, using soil from a sand hill that was in the field. However, the cost was very high and the amount of soil required would have been very large even for a thin mulch.

Deblossoming

Deblossoming was only carried out sporadically because the peak period of blossoming came between two major weeding operations when there were no workers hired. Thus, a fairly large portion of the field was left to produce fruit. Most of the fruit was either removed during the next weeding before it was ripe, or was left to rot. Some fruit was picked by SSPP's partners or friends. Allowing paying customers to U-pick the fruit was considered. However, SSPP decided that the small quantity of fruit and the low price it could command because of the distance from Saskatoon and the fact that the fruit

was covered in sand would not offset the potential damage to the emerging runners that careless pickers could inflict.

Although deblossoming is commonly thought to increase runner production because the plant's energies are turned away from producing fruit, it is expensive and time-consuming. Deblossoming a field must be done over a period of time as the blossoms do not all appear at once. It is estimated that a total deblossoming operation would take about the same amount of time as a weeding operation. Krieger and Tanino (November 2000) reported the results of the first year of a deblossoming study they conducted at SSPP's location. They found no significant differences in rooted daughter production between those plants that were deblossomed and those that were not.

3.3.1.c. Harvesting, Processing and Shipping Marketable Strawberry Plants

Only 305,000 plants were shipped and 220,000 plants sold out of an estimated 615,000 marketable plants in the field prior to harvest. This section provides the details of harvesting and processing problems that contributed to the low number of plants sold.

Harvesting, Processing and Shipping Scheduling

The timeline planned for harvesting and processing was the last week of September and the first week of October. It had originally been hoped that one truck could be used to transport all of the plants to all of the California customers at one time. Up to one million plants can be carried by one truck. However, it became apparent that two partial loads might have to be sent to accommodate different planting schedules and so plants would not be held in storage too long. Bill Ito, a customer from Irvine in Orange County south of Los Angeles, starts planting as early as September 25 and finishes early in October. He wanted some plants at the beginning of his usual planting season and even earlier to test the productivity of early-dug plants from Saskatchewan. He is exploring the possibility of planting as early as September 15. The other customers in the Oxnard area

north of Los Angeles did not want plants until October.[11] In the end, SSPP could not provide early plants in any number for Ito since a decision was made to not begin harvest until the results from the second testing of plant material for nematodes were received.[12] However, two shipments were still planned – one for arrival in California about October 3 and a second shipment about October 10.[13]

On September 22, 2000, SSPP received word that the nematode tests showed fairly high levels of infestation. Additional tests were required to identify the particular species of nematodes present. Suddenly SSPP was in the position of having to delay harvest for at least one wee' later than planned and perhaps not harvesting at all.

SSPP received word on September 29 that the particular species of nematodes on its plants would likely not instigate a quarantine order in California. The partners decided to commence harvest as quickly as possible. However, it soon was apparent that it would be possible to send only one truck and fill only a portion of each plant order because there was only one week to complete harvest and ship the plants to the customers before they finished planting. In addition, the output of the trimming crews was much lower than expected. Bill Ito was going to be finished planting before any plants could be sent but was willing to take half of his maximum order of 200,000 plants. One Oxnard fruit grower where there had been a change in management decided not to take any plants and the other Oxnard growers agreed to take about half of their maximum orders. SSPP's goal became to harvest and process about 300,000 plants in the week rather than 600,000 or more over a two week period as originally envisioned. Seven acres were harvested during the week and a truck was loaded with 305,000 plants early on October 8, reaching southern California on October 10. Unloading occurred on October 11. Three acres were left unharvested at Pike Lake.

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[11]Most southern California producers are moving toward planting earlier, although the Oxnard area will likely always be behind Orange County.

[12]A box of 500 plants was hand dug on September 20 and sent by air the next day to Ito via Los Angeles but it was not able to clear customs and was returned to Saskatoon (see Section 5.2.1. for further details).

[13]The window for delivery is limited. Truckers legally take about 48 hours to reach southern California from Saskatchewan. Trucks have to arrive at California county borders between Monday and Thursday to avoid delays in inspection. If they arrive on Friday they may be held over the weekend for inspection on the next Monday.

Damaged Plants

Only 220,000 plants were paid for by customers because of dissatisfaction with survival rates and productivity. After the plants arrived at the various drop-off points in southern California and were inspected by county officials, they were immediately taken by the customers to their fields for planting. Field workers at one farm noticed that some of the plants were not in very good shape. Some boxes contained plants at the bottom that were damp or, in a few cases, most of the plants in a box had turned black.

Dr. Gary Storey, who was present in southern California troubleshooting the delivery, was in the field when the problem was noticed. He immediately contacted all of the other customers. By this time, the customer with the largest order, Bill Ito at Irvine, had already planted half of his 100,000 plants. He transferred the remaining 50,000 plants to storage trays in his cooler to observe their condition. 25,000 of these plants were used as replacement plants while the rest were discarded. One customer at Oxnard culled his plants before planting and discarded "doubtful looking" plants. He discarded about 10,500 plants out of a total of 40,000 plants. As it turned out, he was very satisfied with the plants he planted. The grower where the problem was first discovered had already planted almost all of his plants when the discovery was made. Another grower decided to go ahead and plant all the plants even after being warned about the problem.

All of the customers were given the option of waiting to evaluate the plants for survival and productivity before deciding what they would pay SSPP. Eventually the various growers estimated their losses at between 15% and 50%. The result was that SSPP received final payment only for about 220,000 plants. The details of these events are provided in Section 4.

There are a number of possible reasons for the deterioration of the plants during storage and transit:

- Frost - the most likely explanation for the deterioration of the plants while being stored and shipped is that they were frost damaged and the moisture in the bottom of the boxes was leakage from plants with damaged tissue. Temperatures dropped below freezing every night at the Pike Lake field during harvest according to the measuring instruments installed there. For five of those nights it stayed below -2°C for between twelve and sixteen hours. On the nights of October 4 and 6, the temperature stayed below -8°C for 5 hours each night and reached a low of below -10°C. Extended temperatures in this range can cause damage to unprotected strawberry plants. Nestby and Bjorgum (1999) tested a number of strawberry cultivars and found that yield was reduced by 41 to 61% when the plants were held at -8°C for 2 hours.

The mornings after the frosts stayed very cold and by the second day of hard frost, the plant harvester's blade could not penetrate the ground in places until later in the day. The plants had been mowed a few rows ahead of the digging operation to reduce the amount of material put through the digger and transported to the trimming shed in Saskatoon. It was in the rows that had been mowed that the ground was frozen hardest, indicating that the lack of foliage there left the crowns more vulnerable to frost damage.

Unfortunately, the boxes of plants from each of the various days of processing were not kept together nor was the date of harvest kept track of. It was not possible to compare boxes processed before and after the frosts for signs of damage, nor to compare frost damage between mowed and unmowed plants. All boxes from California nurseries are labeled with their date of harvest. This omission by SSPP makes it difficult to determine the degree to which the spoilage of plants in storage was caused by the frost. However, plants harvested from SSPP's site after these frosts and planted in the University of Saskatchewan greenhouse exhibited frost damage.

- Heat - The initial suspicion expressed by some customers was that the plants had heated. However, Dr. Storey did not feel that there was excess heat in the centres or at the bottoms of the boxes at the time of their unloading in California. Although heat is not thought to have been the problem, there were periods during processing when excess heat could have accumulated that was not removed in storage. Most of the harvest period was very cold but there were some periods, especially in the first days, when temperatures rose during the day and the sunlight was intense. At these times the plants came from the field holding some heat. A refrigerated trailer had been rented to hold untrimmed plants in storage and bring their field temperature down, but the poor job that the harvester did in removing soil meant that the loads of plants were too awkward and heavy with soil to move in and out of the reefer. Instead, plants were covered with tarps and stored on the ground on the south side of the processing building while waiting to be processed. At times, the sun shone quite intensely on the stockpiled material. The material was periodically sprayed with water to keep it cool and moist, but some loads became warmer than desirable.

The trimming room was quite cool throughout the week of trimming and plants were kept moist through the trimming process. However, the packing room had a tendency to become warmer because of its small size and the large amount of activity in it, even though the furnace was never started. Some boxes of plants were kept open in this environment for too long as they were being packed and then may not have been moved to the cooler after packing quickly enough.

The temperature of the storage reefer for packed plants perhaps could have been kept colder. The target temperature was 1 to 2°C (34 – 35° F). This temperature was chosen rather than the –1.5°C used to store fully chilled plants because the SSPP plants were not thought to be ready for such a low temperature. This decision may have been wrong. Although the boxes were spread out in the storage reefer to allow better cooling, the reefer may not have had the ability to bring the core of the boxes down to the target temperature because of the closed (non-perforated) plastic liner of the boxes. It is known that at California nurseries the heat is removed from

plants before the boxes are closed. The boxes used for the high elevation plants dug at this time of year in California have vents in them and the plastic is perforated, although plants dug later and stored for spring planting do not have perforated plastic. The SSPP boxes had no vents or perforated plastic. It is not known whether perforated boxes will keep enough moisture in the plants during the longer storage and transit period needed for Saskatchewan plants relative to the high elevation plants shipped from northern California to the fruit growers in southern California.

There is the possibility that the transport truck had a breakdown in its cooling system on the way to California. This is not thought to be likely since the company, Martin's Vegetables, is known for the high quality of its trucks. Unfortunately, no recording was made of reefer temperatures during transport.

In retrospect, continuous temperature monitoring should have occurred at every stage of the packing and shipping operation. SSPP has no useful temperature data from the storage period. The thermometer on the storage reefer was checked regularly and boxes were checked randomly, but there should have been methodical probes of the centres of all boxes. SSPP should have placed a monitoring device in the transport truck that would have collected reefer temperature information throughout the movement to California.

- Moisture - Some of the harvest occurred during high winds that may have dried some of the plants out so they were damaged before they even came through the processing and storage process. Other plants may have spent too much time exposed to the air while waiting to be processed or packed. About two cups of water was added to each of the boxes before they were closed to provide some moisture for the plants. The boxes were then turned in storage to move the water through the mass of plants in the box. This water may have collected in the bottom of the boxes during transport and caused spoilage, especially with the impermeable plastic liners of the boxes preventing any air or moisture movement. Plants likely should be sprayed with water from spray bottles rather than moistened by adding cups of water. The

water was added because, in past years, shipments of plants from the University have been too dry on arrival in California. SSPP was more concerned that the plants would dry out than that they would be too wet. [14]

- Unnecessary replacement – Although there were definitely damaged plants in the boxes that went to California, the customers may have been too hasty in replacing some of the plants. It could be that highly chilled Saskatchewan plants may not react the same as California plants immediately after transplanting and may not look as healthy for a period of time. In 1998/1999, test plants arrived at Chas Nakama's operation in Oxnard from the University of Saskatchewan in very poor condition because of improper handling. Nakama planted them anyway and the Saskatchewan plants out-yielded California plants by a wide margin both in the early part of the season and throughout the season.

3.3.2. Cost and Efficiency of Labour and Management

Labour and management are the largest expenses incurred in strawberry plant production. Table 3.6 presents a summary of the costs of labour and management for SSPP's 2000 operations, including a comparison with the estimates provided in *Study 2.* The SSPP labour and management costs are adjusted to reflect what the costs would have been if all of the acres had been harvested and the budgeted number of plants had been processed (675,000), rather than only 305,000.

[14] Late in October 2000, three thousand plants were dug by hand at the Pike Lake site and packed in three boxes for to observe how well the plants kept in storage with packing methods. By this time it was known that there had been frost damage, but the plants seemed to have recovered, having grown numerous new hair roots during the mild weather of later October. One box had two cups of water added and had a closed plastic liner. One box had a closed plastic liner and no added water. The third box had perforated cardboard and liner and had no water added. The boxes were placed in a university greenhouse cooler at about 3 ° C with temperature probes inserted. The internal box temperatures remained about two degrees above the temperature at which the cooler was set, but the temperature differences between boxes were very little. None of the plants in any box showed signs of deterioration for many weeks. Spoilage eventually started in all of the boxes because the temperature was too high for long term storage.

Table 3.6. Labour and Management Costs, *Study 2* vs. SSPP 2000.

	Study 2		*SSPP 2000*		
Variable	*C $/acre*	*C $/1000 plants budgeted**	*C $/acre*	*C $/1000 Plants budgeted**	*C $/1000 plants marketed****
Casual labour - field					
- planting	203.17	2.54	304.56	4.52	13.90
- weed/fertilize/deblossom	812.66	10.16	1,809.50	26.80	82.30
Casual labour – process**	2,167.10	27.09	2,195.00	50.40	69.90
Hourly (term)labour**	550.10	6.88	548.00	10.00	19.40
Management **	1,257.89	15.72	2308.00	39.61	95.80
Workers Compensation Premiums**	88.44	1.11	100.85	2.17	4.70
Total Labour and Management Costs	**5,079.26**	**63.50**	**7,269.00**	**133.50**	**286.00**
Expected Revenue	***8,400.00***	***105.00***	***9,112.50****	***135.00****	***135.00***

Source: *Study 2* and SSPP

*These figures refer to Canadian dollars (estimated for *Study 2* and actual for SSPP 2000) spent per 1000 plants of output, based on the output estimated in pre-production breakeven budgets (80,000 plants/acre on 65 acres and 67,500 plants/acre on 10 acres respectively).

**Only seven out of ten possible acres were harvested by SSPP. SSPP pre-harvest labour and management costs are based on ten acres of production. SSPP post-harvest labour and management costs (all casual processing labour and an appropriate portion of hourly labour and management costs) are based on seven acres harvested. This is reflected in SSPP *$/acre*. Similarly, the figures for these variables under SSPP *$/1000 Plants Budgeted* have been adjusted to reflect the extra labour and management that would have been required to process the budgeted 675,000 plants rather than the 305,000 plants actually processed.

***220,000 plants were marketed.

****Budgeted revenue at 67,500 plants per acre x C $0.135/plant: actual revenue was C $2,970/acre (total revenue divided by 10 acres).

3.3.2.a. Planting Labour

Much of the planting was carried out by the SSPP partners over a one week period using the University of Saskatchewan's single row strawberry planter. Five casual labourers were hired for various lengths of time at minimum wage to assist in the process. The dollar figure in Table 3.6 for planting labour includes the value of both partner and hired labour. There were usually six people planting at one time (one tractor driver, two people planting, one worker supplying plants and fertilizer and two workers setting plants by hand). The maximum number of plants planted in one ten-hour shift was 18,000 plants. While the planting process went reasonably smoothly, there were certain inefficiencies that occurred because the level of experience was low among the partners and workers. Better soil preparation would have improved the quality and speed of the planting. The pre-planting disking did not penetrate the plow layer everywhere so the planter did not

always place the roots into the ground properly and many plants had to be reset. A crew of four to five people should be adequate to plant with a one-row planter in properly prepared soil. In *Study 2*, a four-row planter was used in the estimates. There are labour efficiencies to be gained with the use of larger planters. A larger machine still only requires one tractor driver and the labourers setting plants behind the planter and supplying materials to the planter can be used more efficiently.

3.3.2.b. Summer Field Labour

Summer field labour consists of weed removal, deblossoming, fertilizing and runner setting. *Study 2* estimated the cost of this work at about $812 per acre, based on information from strawberry fruit and strawberry crown producers in other parts of Canada. SSPP's costs for this work were much higher - about $1,810 per acre. Summer field labour was paid either by contract on a per row basis adjusted by the amount of weed cover or by an hourly wage ranging from $6.00 per hour to $9.00 per hour. Included in the $1,810 per acre is approximately $125 per acre of partners' labour.

There are a number of reasons why the cost of summer fieldwork was so high:

- The land was not fumigated. Fumigation is reported to eliminate a complete weeding operation.

- The land had some problem weeds that took extra effort to control including burr, volunteer canola, Canada thistle, redroot pigweed, green foxtail and wild oats. Each of these weeds needed attention at different times, increasing the number of weeding operations. For instance, a September weeding was required to remove large redroot pigweed plants that had been missed when the plants were small because they were difficult to see among the strawberry plants. Many fields used in crown production elsewhere have been in that use for many years and weeds have been controlled carefully. This means that weed populations are generally low. Renting the Pike Lake land in the winter with no observation of it during a previous growing season

left SSPP open to the risk of problem weed infestation. In fact, the weed population, while somewhat problematic, could have been much worse.

- The land was weeded in four separate weeding operations using large groups of labourers. There was quite a high turnover of workers with the result that new workers were continually having to become conditioned physically and learn to weed (about forty different individuals were employed for various lengths of time throughout the summer). There also was a learning process for the management in terms of effective management of workers. Some weeding was done by hourly workers in between the major weedings. It may have been more cost-effective to have a smaller crew continually weeding, so that experienced workers were retained and the weeds were removed at a small size with minimal effort.

- Weeders were paid by the row during the first weeding while much of the succeeding weeding was paid by the hour. It was difficult to calculate suitable contract prices because the weed population varied so much across the field. However, most weeding should be carried out on a contract system to encourage initiative in the workers and reduce the level of management needed.

- The planting configuration of double rows with the runners placed within the double rows meant that a large area of the field had to be hand weeded after only one weeding. Single rows would allow more mechanical operations which are much less expensive. The planting system also required more runner setting to keep runners from growing out into the cultivated area between the sets of double rows. As noted earlier, this may have had a negative impact on production since runners continually had to be turned away from the natural direction they were growing and often did not root successfully after being moved.

- The predominant source of labour was young men, mostly of aboriginal descent. Many of these men were willing and able to work long and irregular hours. However, the lifestyle of many of them affected the consistency with which they came to work,

so crews varied in number from day to day. There may be other sources of weeding crews, such as Hutterite colonies, student groups or fund-raising groups who may be more consistent and less expensive. However, the work is hard and not everyone is willing or physically able to do it effectively.

- Field labour must have access to the proper hand tools to work effectively and for long periods of time. A number of types of hoes were tested before suitable tools were identified. The best long-handled hoe found for the average weeder is a beet hoe with a small blade and very sharp corners, available from Canadian Tire. When it is necessary to get closer to the weeds in later weeding operations, a short handled Japanese hoe with very sharp blade and corners, available from the Saskatoon Horticultural Society is very useful. Conventional hoes are heavy and slow. Some workers found push-pull type hoes to be effective.

3.3.2.c. Harvesting Labour

The labour requirements of the harvesting process are quite low. Two workers who had worked through the summer intermittently weeding, irrigating and fertilizing were hired at $10.00 per hour to mow plants, run the harvester and transport plants to the processing shed in Saskatoon. These men were mechanically adept and experienced machine operators, so they required little supervision. Because harvesting took only a short period each day to keep up with demand from the trimming shed and because the harvester was not removing enough soil even with the plants put through it twice, more labour and time should have been used in the field to ensure the plants came to the processing shed free of soil. Plants could have been dropped in a windrow by the harvester. Two labourers in the field then could have loaded the truck using forks. This process would have left the plants very clean and would have eliminated many difficulties at the trimming shed in terms of handling and storing unprocessed plants. This seemingly inefficient method of loading plants by hand was observed in Nova Scotia, but the purpose of it was not realized until the problem was faced here. In the large nursery operations in California,

harvested plants are put though a rotating drum on the harvester to remove soil before being loaded on trucks.

3.3.2.d. Processing Labour

Most of the processing labour was employed in the actual trimming of the plants, but several people on each shift were employed to box the plants or to supply plants to trimmers and remove discarded plant material. Plants were trimmed at long tables, each with several workstations with sickle blades mounted in an upright position. Trimmers were each given a pile of plants that they sorted, separated and then trimmed using the mounted blades. The trimmed plants were set to the side and packers took them away to the packing room periodically.

The low productivity of the plant trimmers was one of the most costly problems for SSPP in its inaugural year and will continue to be an area of great concern into the future. It is well-known that labour for this type of handwork in the amounts required and at affordable prices is difficult to find in Saskatchewan.

Observation of plant processing in Eastern Canada suggested that 3000 plants trimmed per eight hour shift per trimmer would be a reasonable number to plan for, given the lack of experience in Saskatchewan. The piecework rates paid for trimming in Eastern Canada work out to about minimum wage levels ($5.50 to $6.00 per hour) for a trimmer for 3000 plants per shift. Spread across the packing labour and other support labour, 3000 plants per shift per trimmer would equal about 2,500 plants per shift per processing worker.

The average number of plants trimmed per processing worker in the SSPP operation in October 2000 was about 1,150 plants per eight hour shift (spread across all processing workers including packing and support labour). The workers actually worked seven hour shifts but this is factored into the calculation. Most workers were paid at minimum wage, with a few receiving as much as $8.00 per hour toward the end of the week in recognition of their productivity. Measurements of the productivity of some of the

fastest trimmers through the week showed that it should be possible to increase the average rate of trimming to the levels estimated in *Study 2*. However, there was not enough time because of the shorter than expected harvest season in 2000 to institute many of the changes in physical layout of the processing line and changes in management of labour that would have increased overall efficiency. There are a number of reasons for the low productivity that occurred:

- Virtually none of the workers had any experience with this type of work. Three experienced nursery workers were hired who had reasonable productivity from the beginning and other workers became more proficient as time went along. It was originally hoped that more laid-off nursery workers would be employed but many of the ones contacted were not interested at the level of wages paid.

  Some of the labour that was hired was of low skill, physically unsuited, or not very committed to the work. About one hundred labourers were hired through the week of trimming to keep two seven hour shifts a day going. These shifts consisted of from twenty to thirty-five people depending on the day. Labour was obtained through newspaper advertising, job postings with Canada Manpower and at the university, and by searching for workers on the street at such locations as the Salvation Army. Because of the uncertainty that surrounded the harvest date or even whether there would be a harvest because of the nematode issue, it was difficult to make the necessary arrangements to have groups of workers come in such as Hutterite colonies or fund-raising groups that may have provided more reliable and proficient workers.

  SSPP had talked with Cosmopolitan Industries about contracting the work. Cosmopolitan Industries employs intellectually challenged individuals in sheltered work settings. Cosmopolitan, though initially interested, was concerned about the pace of work and the potential risk to workers around the sharp trimming instruments and decided to not make a contract with SSPP.

- The time frame for developing proficient trimmers was too short. Harvest was held up for a week because of the nematode issue. Because of this problem the total harvest/processing time was cut in half. Many workers were increasing their output daily and this would have continued throughout a second week of harvest, significantly increasing the average output per worker per day. Other workers who should have been let go were kept on because locating replacement workers was difficult and in the extreme pressure to supply the minimum number of contracted plants to California customers, total production rather than productivity per worker became important.

- The incentive system was not correct for the situation. Workers started at minimum wage and were offered small wage increases if they were more productive than average. Because of the abbreviated time frame and the extreme pressure there was no time to judge workers consistently by an objective standard. There was no ability to differentiate adequately in terms of pay between the worst and the best workers. Piecework rates are likely the only way to produce the level of productivity required for this operation. Piecework, if priced right, will tend to remove the poorest workers automatically while providing the best trimmers with adequate incentives. There are other labour management ideas that also need to be explored such as forming teams of workers who process the product from delivery to the processing shed right through to packing. They would be paid as a group.

- The harvesting process did not remove enough soil from the plants. Thus, too much soil was trucked into Saskatoon and had to be handled while the truck was unloaded and as plants were processed. This increased the time spent removing soil from individual plants and during clean-up between shifts. Unloading the truck became very time-consuming and exhausting, as the soil tended to jam the load into the truck and plants were removed with rakes or by hand in small bunches. In addition, fuel costs were undoubtedly higher because of the extra truck weight per load. To try to solve this problem, the plant material was run

through the harvester twice in the field. This was only partially successful. A better solution, while labour intensive, would have been to have all of the harvested material dropped on the ground and then hand-forked into the truck in the field.

- The ground began to freeze over several nights of heavy frost during the harvest. This increased the amount of soil left attached to the plants and made it very difficult to remove, requiring extra time and effort by the trimmers. Some mornings, trimmers had to bang frozen clumps of soil from the plants vigorously which was neither efficient nor good for the plants. The frozen plants were also very hard on workers hands, since only thin surgical gloves could be worn.

- The cold weather made working conditions for the trimmers quite uncomfortable. The temperature in the trimming shed in the mornings was often just above freezing. Adding forced air heat (which was the heat available) to the trimming sheds would have dried the plants out.

- Too many plants (30%) were rejected according to Dr. Storey's observations in California. The time taken to reject a higher percentage of plants increases the time spent per plant trimmed. It takes about the same amount of time to reject a plant as to save it.

- The quality of trimming and packing was too high as observed by Storey in California when comparing the SSPP packed product to the packed product of the major California nurseries. There was too much emphasis in the SSPP operation on careful trimming and stacking of plants for boxing. More emphasis should have been placed on speed and reaching certain trimming targets. Plants were trimmed too close to the crown, which requires extra care. The California nurseries often leave stems projecting two inches past the crown. Trimming at that location on the plant is much faster since there is less concern about

damaging the crown. Plants were counted and packed too carefully in the boxes. This required extra workers, reducing productivity.

- The trimming shed space (24 feet by 50 feet) was not quite big enough, creating some congestion, so that trimmers were sometimes left waiting for plants. A larger shed would have facilitated the use of a skid steer loader to bring in plants and remove waste while trimming work continued. A loader was brought in once to clear out the shed of accumulated debris. Trimming had to be shut down during this process.

- There were a number of physical adjustments that needed to be made to the trimming and packing space to increase efficiency. For example, more time should have been spent adjusting trimming tables to workers' height and working spaces should have been assigned to workers on this basis. Trimming is hard work and productivity will decline quickly in poor working conditions.

It should be quite possible to double the per worker rate of trimming if the above issues are solved. Although high turnover of labour is to be expected in this type of work, over time a core of experienced workers may return year after year if the incentives are correct. Trimming and packing productivity should then continue to increase.

3.3.2.e. Field Supervisor/ Manager

The estimated annual cost for management and field supervision in *Study 2* for a 65 acre operation producing 5.2 million plants (8 plants per mother) was about $83,200 (full time manager at $50,000 per year plus benefits; 33 week term for field supervisor at $17.00 per hour plus benefits). This is a cost of $0.016 per plant. The cost of management for SSPP totaled $21,100 for all partners' management and supervision. If SSPP had sold 800,000 plants (8 plants per mother), the cost of management per plant would have been $0.032, or double that estimated in *Study 2*.

There are a number of reasons that management costs were so high. The role of field supervisor was combined with that of manager and paid on an hourly basis of $20.00 per hour because of the small size of the SSPP operation and the need for the manager and other partners to closely observe, manage and document field and processing activities in the first year of operation. This approach, while useful in the first year, was expensive. There were times when the manager had to be present during field operations when a lower paid field supervisor would have been sufficient, leaving the manager to work on other aspects of the business or to take time off. However, it was not possible to always predict this in advance. In addition, it was not easy to hire a competent field supervisor on a casual basis which is what was required given the sporadic nature of the fieldwork. There may be potential in the future of contracting some field operations, especially weeding, out to a contractor who would have to source the labour. This occurs in California. Toward the end of the 2000 season, certain of the field activities such as irrigation and harvesting were taken care of without management presence by hourly field workers for a wage of $8 to $10 per hour. This was considerably below the projected field supervisor cost in *Study 2* of $17.00 per hour.

The limited size of the operation increased the management costs per unit of production. A manager (or a field supervisor) could manage a larger number of acres of production without a significant increase in hours, especially as expertise is gained in labour management and the required production process.

By the end of the week of processing in October, it was apparent that a processing shed supervisor should have been hired to concentrate on direct management of the workers. This would have allowed the manager to concentrate on business and marketing work, the overall improvement of harvesting and processing efficiency, labour planning and incentive structuring.

3.4. Other Input Variables

There are a number of important production and processing variables other than the variables identified as critical and discussed in the preceding section. Some of these other variables have already been discussed in terms of their impact on the most critical production variables. Others do not directly affect these critical variables. However, they are important to the overall cost structure and productive capability of a strawberry plant production operation. The costs associated with these input variables are compared in Table 3.7 to cost estimates made in *Study 2.*

Table 3.7. Other Production, Processing and Shipping Costs: *Study 2* vs. SSPP 2000.

Variable	*Study 2*		SSPP 2000		
	C $/acre (65 acres)	C $/1000 plants marketed (5,200,000)	C $/acre (10acres)	C $/1000 plants marketed (675,000 budgeted)	C $/1000 plants marketed (220,000 actual)
Seedstock	882.00	11.00	840.00	12.40	38.20
Fertilizer and Pesticides	72.00	0.90	95.50	1.40	4.30
Fuel, Repairs and Utilities	158.00	2.00	288.00	4.30	13.10
Office Expense and Telephone	79.00	1.00	91.50	1.40	4.40
Marketing and Travel	308.00	3.80	440.00	6.50	20.00
Packing Material	162.00	2.00	208.00	3.10	9.50
Shipping	240.00	3.00	302.00	4.50	13.80
Annual Machinery & Building Costs	1,344.00	16.80	785.00	11.60	35.70
Insurance, Taxes, Licenses	41.00	0.50	121.00	1.80	5.50
Inspection	40.00	0.50	93.00	1.40	4.30
Total	**3,680.00**	**45.90**	**3,281.50**	**48.40**	**148.80**
Start-up Costs*	354.00	4.40	-	-	-

Source: SSPP.

*Startup costs such as water, gas and electricity installation are incurred only in the first year of production so are kept separate from the other annual expenses.

3.4.1. Seedstock

'Camarosa' seedstock was purchased from California nurseries in 2000. The necessity of ordering seedstock from competing nurseries and from an area where there is potential for pest and disease problems is a potential problem for future plant production is

Saskatchewan. Although the plant material received by SSPP in 2000 seemed to be free of disease and pests, there is a possibility that the nematode problem experienced by SSPP may have originated with the California material (this issue is discussed in Section 5.2.2.f.). There have been reports from Saskatchewan strawberry fruit producers who order plants from California that they have received plants infected with anthracnose. This suggests that an industry in Saskatchewan may need to be able to produce plants further up the certification hierarchy in the province to protect the ensure the availability and quality of the seedstock used. The ideal situation would be to produce seedstock from the nuclear level down, but obtaining nuclear stock for patented California varieties is unlikely and the process of developing Saskatchewan varieties that are in demand in California will be long and uncertain (see Section 7.1).

Registered plants must be used as seedstock in the production of certified plants. In late March, 2000, registered Camarosa plants were ordered from Lassen Canyon Nursery of Redding, California (52,000 plants) and from NorCal Nursery of Red Bluff, California (51,000 plants). These are the two largest nurseries in California and likely in North America. The plants cost US $50.00 per thousand picked up at the nursery. NorCal originally wanted to charge US $60.00 per thousand until informed of Lassen Canyon's price. This indicates there is some flexibility in pricing.

Lassen Canyon and NorCal have good reputations for supplying high quality seedstock, although from conversations with various California growers, NorCal's reputation does not seem to be as consistent. The Lassen Canyon plants that SSPP received tended to be larger with more roots than the NorCal plants and the overall quality and consistency seemed to be better. Although records were kept of where the NorCal and Lassen Canyon plants were placed in the field, there was no visual difference noted in the growth of the two groups of plants and no comparative measurement of yields was made at harvest.

Several other charges must be added to the basic cost of the seedstock. Lassen Canyon charged US $36 for USDA phytosanitary certificates, while NorCal charged a US $100

fee for a phytosanitary certificate, documentation and handling. NorCal shipped almost twice as many plants as Lassen Canyon since SSPP ordered plants of other varieties from NorCal on behalf of a number of Saskatchewan strawberry fruit producers. NorCal also originally added a royalty fee, until reminded that University of California patented plants transferred between licensed nurseries and used for multiplication have no royalty fees attached.

Trucking of seedstock was arranged with Martin's Vegetables of Saskatoon. The cost was shared with several Saskatchewan strawberry fruit producers who had also ordered plants from California. This reduced the cost of shipping from what it would have been if SSPP had shipped its plants alone, but not to its minimum potential level of about C $3.00 per thousand plants since the truck still was only partially filled. The trucking cost to SSPP was about C $5.25 per thousand plants.

Customs brokerage fees also must be added to the cost of seedstock. These fees amounted to C $162.25 for brokerage, CFIA application and inspection, outport fees and fax charges payable to Percy H. Davis, customs broker. GST was charged at the border on the shipment but this was a refundable expenditure. SSPP was able to recover some of these expenses by charging a small handling fee to the Saskatchewan strawberry growers who ordered plants through SSPP. The total cost of seedstock was about US $55 per thousand for SSPP in 2000 versus the US $60 per thousand estimated in *Study 2*.

3.4.2. Fertilizer and Pesticides

Fertilizer use is described in Section 3.3.1.b. and in Table 3.5. There were no pesticides used by SSPP in 2000, but this may not be the case in other years, since strawberry pests do exist in the province. The higher fertilizer cost for SSPP than that estimated in *Study 2* resulted from increases in the cost of fertilizer since *Study 2* was completed, extra costs associated with purchasing small amounts of fertilizer (some bagged and some bulk was purchased), the inclusion of sulphur in the fertilizer, and the low fertility of the soil at Pike Lake which required additional fertilizer applications during the growing season.

3.4.3. Fuel, Repairs and Utilities

SSPP's fuel, repair and utility costs were almost twice as high on a per acre basis as the estimate in *Study 2.* This increase was almost all from fuel costs, since repair costs were minor and there were no explicit utility costs incurred (all electricity and natural gas was included in the price of the processing shed). There are a number of reasons for this high fuel cost:

- the price of fuel rose to very high levels in the summer of 2000.

- the pickup truck leased by SSPP on a part-time basis was a full-size mid-1980's model extended cab vehicle that had high fuel consumption.. A truck of this size was required at times to move materials and field workers from Saskatoon to the Pike Lake site. It had been hoped that local workers with their own transportation could be hired for field work, but this was limited to a few workers, even though local advertising for labour occurred. The same pickup truck also was used for most irrigation and inspection visits to the site from Saskatoon. Fuel costs would have been much lower if a more fuel-efficient vehicle had been available for these often single-person trips and if this work had been carried out by a local person, as occurred near the end of the season. There would be returns to size in terms of vehicle fuel consumption since the number of inspection and irrigation trips likely would not rise much for a larger acreage.

- the plants were hauled about forty-five kilometres to the processing shed using a three-ton gas-powered farm truck. This truck also had very high fuel consumption.

- the above vehicles were leased by SSPP under favourable lease conditions which offset some of the higher fuel consumption costs.

- the costs of using refrigerated trailers with diesel compressors for plant storage can run quite high, although the cold weather during the harvest and processing period in 2000 kept this cost down. Some refrigerated trailers can be switched to cheaper three-phase electricity if it is available, but this was not the case for SSPP in 2000.

3.4.4. Office Expense and Telephone

Office expense was minimal since the partners contributed the use of computers and office supplies. Two cellular telephones supplied by one of the partners were used to conduct business from the field and processing shed. The majority of this category of expense was the cost of calls made with these telephones, often to recruit workers or locate supplies, and business calls to California and other locations from partners' personal telephones. This expense could have been lower if a more economical cellular calling plan had been arranged at the beginning of the season, but the extent of the use of cellular phone services was unknown at that time.

3.4.5. Marketing and Travel

Per acre marketing and travel costs should decrease as the size of the operation increases, since a small operation must incur many of the same costs as a larger operation. The most important marketing tool in this industry is personal contacts with customers and potential customers. Therefore, even a small operation such as SSPP needs to send representatives at least twice a year to visit customers, especially in the early years of production. SSPP sent a representative to visit customers three times. The most important times to send representatives are in late winter/early spring to check on the progress of the plants sold the fall before and make new sales agreements, and in the fall as the plants arrive from Saskatchewan. There may be other requirements for personal visits such as problems with the plants at other points in the growing season, to collect market information or to deal with regulatory issues. Section 4 looks at the requirements of marketing and at SSPP's marketing experience in greater detail.

3.4.6. Packing Material

Packing material expense is considered separately in this section from shipping expense. In the complete budget presented in Table 3.1, packing material was included in the cost of shipping. Packing material consisted of custom-ordered two cubic foot full-overlap boxes of heavy paper (275 C Kraft), plastic box liners, packing tape, tape applicators and adhesive labels. The size and material for the boxes was based on the boxes in which the seedstock had come from California. It may be possible to find other more economical packing materials and dimensions over time. However, in the first year of operation it seemed wise to ship a product that was packed similar to competitors' products, since the minimum practical and regulatory requirements for shipping containers were not well understood. Adhesive labels were used because printed labeling would have been too expensive, given the large number of labels required (see Section 5 and Appendix B) and the relatively low number of boxes ordered.

The SSPP costs for packing material in 2000 as shown in Table 3.7 are higher than should have been incurred. Enough packing material was purchased for 800,000 plants at 1000 plants per box to ensure that there was enough material to last through the processing period. Less than one half of this material was used because it was possible to pack 1,250 plants per box and because of the low output of the operation. Unfortunately, excess custom-made packing material is difficult to resell and SSPP incurred the full cost of the material purchased. The cost of packing material per thousand plants in 2000, given the material used, should have been in the C $2.50 per thousand plant range, somewhat higher than estimated in *Study 2*. There can be savings at larger scales of production. If it is found that a different type of packaging is required to avoid the spoilage problems experienced in 2000 (described in Section 4), there may be an increase in the packaging costs.

3.4.7. Shipping

Shipping costs were higher for SSPP in 2000 than estimated in *Study 2* because of SSPP's low production and because of costs which *Study 2* did not include (customs

broker fees and cooling facility rental in California). The actual cost per load of hiring refrigerated transport to California was similar to *Study 2*. Shipping costs incurred include:

- C $2,500 - refrigerated transportation of the plants to California. SSPP had to pay the full cost of a truck to California even though the truck was only about one-third full. One truck can haul up to 1,000,000 plants depending on the weight of the plants in any given year. Shipping costs per thousand can be reduced if trucks can be filled.

- C $400 - customs broker fees for services rendered at the border. It is necessary to engage the services of a broker to move a shipment through the border. The broker expects the shipper to prepare the required export documents (NAFTA Certificate of Origin, Customs Invoice and Commercial Invoice). The broker used by SSPP, Percy H. Davis, arranged for an American broker to actually handle the transfer across the border. Broker charges are partially based on the value of the shipment and the number of customers to which the shipment is being delivered.

- C $130.00 - use of a commercial cooler in California for inspection and as a distribution centre. Plants were delivered to centralized delivery points in each county where there were customers, to facilitate county inspection and plant distribution. The truck must be able to unload quickly and move on to the next delivery point. This arrangement is made in consultation with customers and inspectors.

3.4.8. Annual Machinery and Building Usage and Costs

SSPP did not purchase any buildings, machinery or tools except for a small number of hand tools (hoes and fertilizer spreader with a total value of less than $500). All machinery was rented mostly from the landlord. Rates were based on The *SAF Custom Rate Guide for 2000.* The processing shed and refrigerated storage trailers were leased for short periods of time during harvest. *Study 2* presented a production scenario where

there was a mix of owned and rented/custom hired buildings and machines. In Table 3.7, SSPP's total annual cash costs for accessing machinery and buildings are, therefore, compared to the total of *Study 2's* annual machine rental, custom work, depreciation and the annual cost of a machinery loan. The depreciation for *Study 2* is represented in this comparison by the full Capital Cost Allowance figure in the first year of operation (C $47,600) rather than the 50% allowed for taxation purposes. The interest amount included in the *Study 2* Machinery and Building annual cost is the interest on a loan for the full value of the machinery and buildings purchased (some new and some used). SSPP's costs of accessing tools and buildings were much lower on a per acre basis than the operation in *Study 2.* However, the equipment available on a rental basis was not always optimal for the work. The following discussion describes the various machine and building requirements and costs over the course of the SSPP production and processing season in 2000.

Truck Lease ($600) – A mid-80's half-ton truck with an extended cab was leased from one partner for the production season at a rate reflecting its part-time use. The truck was actually used more intensely than expected hauling machinery, fertilizer, seedstock and workers.

Measuring Wheel ($45.00) - A measuring wheel was used to lay out a field design that would minimize the inconvenience to the landlord and target the application of irrigation water on the strawberry plants.

Double disk and 135 h.p. tractor ($6.87/acre x 32 acres) – SSPP double disked most of the field three times prior to planting. However, ploughing may be necessary in the future. SSPP found that the double disk used did not penetrate the plow layer in all places, resulting in poor placement of roots by the planter. This increased the labour component of planting, as many plants had to be set by hand. Plants also were likely set back, although very few died.

Strawberry planter ($25/day x 8 days) and *18 h.p. Kubota tractor* ($7.50/hr. x 67 hrs.) – The planter was rented from the University of Saskatchewan Plant Science Department for a minimal charge. If more acres than ten were to be planted a larger planter would be desirable to speed up the operation. A larger planter also uses relatively less labour. The Kubota tractor was rented from the landowner. A larger planter would require a larger tractor.

18 h.p. Kubota tractor and rototiller ($12.50/hr. x 36 hrs.) - It had been planned that mechanical cultivation would be carried out with a cultivator rather than with a rototiller but even a three point hitch cultivator wandered too much within the narrrow confines between rows. Cultivation would have had the advantage of being much faster and also less expensive per hour, since the rental costs of a cultivator would have been less than for a three-point hitch rototiller. Cultivation may also have assisted with setting at least some of the runners by brushing them back into the row, if it was always done in one direction. Four cultivations were carried out. The first cultivation was between all of the rows. The next three cultivations were in the five foot spaces that separated each pair of rows on a three foot spacing. The drawbacks of this pattern of planting and cultivation have been discussed already in Sections 3.2 and 3.3.

Digger and 135 h.p. tractor ($62.50/hr. x 12 hrs.) – The digger was actually a mint harvester owned by the landlord that was minimally modified by removing the rototiller at the front. It had a 60-inch wide undercutting blade and a conveyor with a side-delivery loading boom. The digger worked well except that it did not agitate the plants enough on the conveyor to remove enough soil. This was a significant and costly problem for transporting and trimming plants. If this digger was used again, either some agitation mechanism would have to be added or the digger would have to unload in a windrow on the ground with labourers loading the windrowed plants into the truck or trailer. The digger is manufactured by Newhouse Manufacturing Company of Redmond, Oregon and costs US $17,305 (about C $26,000) FOB the plant (2000 price).

Mower and 25 h.p. tractor ($50.00) - Mowing took a minimal amount of time. Plants were mowed before digging to reduce the amount of foliage trucked and handled in the warehouse. Mowing was only carried out a few rows ahead of the digger. If the entire field had been mowed before the hard frosts that occurred, the damage to the plants would likely have been greater. It was obvious after the frosts that the plants that had been mowed but left in the ground had suffered the greatest frost damage.

Three–ton truck ($36.00/hr. x 28 hrs.) – A grain truck was rented from the landowner to haul plants to the trimming shed. The haul was about forty-five kilometres into Saskatoon. If SSPP had had more cooler space available, it may have been more economical to harvest larger quantities of plants at one time and hire a larger truck to transport them. The farm truck was slow and fuel-inefficient. The costs of running it were increased because of the large amount of soil carried in from the field.

Portable Toilet (100.00/month x 5 months) – It was necessary to provide toilet facilities for the large groups of people that were sometimes employed in the field. Since there are pick and delivery charges, it was about the same cost to keep a portable toilet continuously at the field site as to bring one in during intensive weeding activity and then have it removed.

Storage Reefer Rental ($450.00/reefer/week) – Two forty-eight foot diesel-powered storage reefers were rented for harvest time from FleetGuide in Saskatoon. One reefer was meant to hold untrimmed plants while the other was to hold the packed product. The untrimmed plants were too awkward and heavy with soil to move in and out of a reefer easily, so one reefer was not used. There is a range of opinion on the ability of a reefer trailer to bring down the internal temperature of boxes if the material in them goes into the reefer warm. Given SSPP's problem with spoiled plants in 2000, it is necessary to carefully watch the cooling process and use temperature probes frequently to ensure that the refrigeration unit has done its job and plants are actually shipped at the correct temperature.

Trimming Shed ($1000.00 for one month, utilities included) – A section was rented in a building on 11th Street West in Sasakatoon. It consisted of an open area of about 24 by 50 feet with a large overhead door at one end and a separate front office area used for packing plants and administration. The filled boxes were taken from this area to the reefer storage just outside the building. There was one washroom just off the trimming floor which seemed to be adequate for the number of people working (up to 45 workers but most often 25 to 30). The space could have been larger to facilitate plant delivery and removal during trimming. However, the location was good for many of the workers and the price reasonable.

Skidsteer Loaders and Trucks ($1,150.00 total for three cleanup operations) – Plant distribution and waste removal was carried out manually in the trimming shed because of the cost of renting a skidsteer loader, the limited space and the lack of experience regarding the amount of waste material the process would generate, even after mowing the plants. However, it was necessary to remove a large amount of waste plants and soil from the rear of the building three times and to clean out the building itself once between shifts using skidsteer loaders and dumptrucks. The material would begin to heat if left too long. The poor job the digger did in removing soil contributed to this problem. Of course, the material had to be taken to the landfill because of the location of the trimming shed in the city. Given the fairly high cost of bringing in loaders and trucks for specific tasks, it would probably be worthwhile to lease a loader through the processing period so it was available to use at all times for unloading trucks, distribution of plants and cleanup.

Trimming Tables ($150.00) – Some of the trimming tables were built from used material that was available for free. Other tables were rented. Sickle knives were mounted on the tables as the major trimming tool. Generally four people worked at each trimming table. Adjusting the height of the trimming tables to the workers' height is very important to workers' comfort and health and, thus, productivity.

3.4.9. Insurance, Licenses and Taxes

Insurance costs were higher than expected for SSPP in 2000. It was advised that SSPP purchase liability insurance that would cover it not only in Saskatchewan, but throughout the transportation of the plants to California. This policy cost $1,100.00. There were no insurance charges for vehicles, since those were part of the rental agreements. A provincial business registration license was purchased for $110.00.

3.4.10. Inspection

An official and accepted inspection system will be integral to successful marketing, especially to California. Section 5 deals at length with the inspection regime put in place in 2000 with the assistance of the University of Saskatchewan, SAF and CFIA. In 2000, the inspection system was mostly *ad hoc,* based on what was known of the demands in California. The field inspections were carried out at no cost to SSPP since the regulatory officials viewed it as a learning experience. CFIA charged minimal amounts for the issuance of phytosanitary certificates for the packed plants. The largest expense was related to the submission of plant samples to the University of Guelph Pest Diagnostic Clinic to test for nematodes. The samples were collected according to the directions laid out in the California regulations requiring root samples collected on a forty foot grid throughout the field and composited on a one acre basis. The cost for this nematode test was $900.00. The development and application of an inspection system will certainly have costs. It remains to be seen who will bear the costs of this system, if strawberry plant production takes hold in the province.

3.411. Start-up Costs

SSPP had virtually no start-up costs because it did not invest in land, buildings or equipment. Eventually it is expected that a continuing production operation will have to incur some of these costs, which can be considerable. Decisions will then have to be made as to where the home base of the operation will be, weighing the value of various

factors such as proximity to the production area, availability of labour and services and costs of erecting and servicing permanent structures.

Section 4. Market Development and Marketing in Southern California

This chapter presents some of the issues involved in marketing strawberry plants to growers in California and describes and analyzes both the work carried out in the area of market development by the researchers and the specific marketing procedures that were followed by SSPP in 2000.

4.1. Markets

The North American market for strawberry plants (crowns), including the specific areas of market potential for Saskatchewan-grown plants, was described in detail in *Study 2.* The general information on the market is not repeated here. This section focuses on the southern California market because this market appears to have the most potential for Saskatchewan-grown plants. Southern California, for the purposes of this discussion, includes the area from Ventura County south. As outlined in *Study 2,* the southern area comprises about 8,600 acres of strawberry fruit production with a total annual plant demand for approximately 170 to 230 million plants with an estimated value of about US $8 million to US $13 million. There are a number of large strawberry fruit growers in this area. Over the last several years, University of Saskatchewan researchers have developed good relations with several large growers who have from one hundred to six hundred acres in annual production and, in total, control about twenty per cent of the southern California acreage.

The prime advantage sought by southern California fruit growers from Saskatchewan-grown plants is earlier chilling than can be obtained from plants grown in the high elevation nurseries of Northern California, the primary source of early plants now. Early chilling allows early nursery harvest and replanting in southern California and,

potentially, earlier fruit production during the high-priced early winter season. This trait will be in increasing demand since southern California growers have been moving to earlier planting over the last several years. Discussion with growers in July 2001 confirmed that with increased strawberry acreage coming in 2002 they will be looking at even earlier planting.

In some years, high elevation northern California nurseries such as the Lassen Canyon nursery at McDoell (1300 metres elevation; latitude 41.8 degrees N) have excellent chilling by late September but this is not consistent from year to year. It is hoped that Saskatchewan is able to more consistently provide the necessary level of chilling at an earlier date than the earliest California nurseries. Southern California fruit producers are willing to pay premium prices for this trait. For example, nurseries with acreage at higher elevations such as McDoell obtain a $10 premium per 1000 plants over lower elevation plants such as at Susanville.

Communications with fruit growers in the Santa Maria area about one hundred miles north of Ventura County reveal that growers in that area are not interested enough in early availability of plants to pay a premium because they cannot compete with southern California on the basis of early production. However, there are other reasons that California producers in general may be interested in Saskatchewan plants, including access to new sources of disease-free, vigorous and high-yielding stock, especially given the concerns over the ability of California nurseries to produce such stock with the imminent loss of the soil fumigant methyl bromide. Strawberry fruit growers further north in California may in the future demand Saskatchewan plants if their overall vigour and freedom from disease and pests is accepted as being as good as or better than California plants. An organic strawberry fruit producer also was visited in the Santa Maria area to try to determine if there was a demand for organic plants but the visit was inconclusive as to potential demand. Aside from these initial contacts, the area north of Ventura County has not been adequately assessed for other market opportunities for Saskatchewan plants.

4.2. Marketing in Southern California

4.2.1. The Marketing Environment

As outlined in *Study 2* there are about 15 strawberry plant nurseries in California of which the NorCal and Lassen Canyon nurseries account for about half of all plants produced. In most cases, only a portion of a nursery's production is devoted to the production of premium-priced high elevation early plants for the southern California market although there may be some small nurseries that specialize in high elevation plants. Other production takes place at lower elevations in central California where yields of plants are much higher, for customers who have no requirements for early plants.

It appears as if the nurseries operate competitively with each other and that the nursery industry operates independently from the fruit industry in terms of business alliances. Some large fruit growers have past experience in plant production but the researchers are not aware of any they have dealt with that currently produce plants. Except in years where there are shortages of plants, the large strawberry fruit growers of southern California have quite a bit of market power and must be "wined and dined" to attract and keep their business (as stated by one nursery owner). In such an environment it is imperative that nurseries maintain a good reputation in terms of quality of plants and ability to deliver on time. The business is done largely on a verbal contractual basis although invoices are involved for confirming orders and price.

Southern California fruit growers, in conversation with the researchers, mentioned nurseries that had lost their confidence because of poor product or service. Various fruit growers have differing opinions of nurseries and many seem to have long-standing loyalties to specific nurseries. Although fruit growers warned that they have very little patience with nurseries that have quality or service problems, they also mentioned that they have had to be patient while some nurseries in difficulty have worked out their

problems. There is not an endless choice of plant suppliers for fruit growers who want to plant early.

Since repeat business is crucial to a nursery's long term success it is important for nurseries to be able to service their customers. This means having an agent available to check into growers' concerns and any problems that might ensue over plant quality. Growers generally expect to have to replace one to three percent of plants. Anything above three percent becomes a concern and the nursery needs to stand ready to reduce the invoiced plant numbers for a higher level of loss. The grower will be quick to tell the nursery that there is a high cost to him for replacements that extends well beyond the cost of the actual plant replaced. First is the labour cost of replacement. Second is the unevenness that is imparted to the field by replacements, which in some cases may not occur till three weeks after the first planting. This affects all production and picking regimes. The higher the replacement rate the bigger the problem.

The need to service customers creates a problem for a Saskatchewan-based nursery because of distance. It is costly to travel to California. However, the critical time for in-person service is likely at the time of plant delivery and the following two to three weeks when problems are likely to develop. It is at this time that a Saskatchewan company is most likely to have a representative available. Once plants are growing there is likely little need for field inspection and, thus, visitation.

Fruit growers follow the course of the nursery growing season with interest. Many will actually visit the nurseries, usually in late summer and early fall, to inspect the plants, determine plant numbers and monitor the progress on chilling. Fruit growers know that if it is a poor plant production season, nurseries could be forced to cut back orders and a fruit grower could face a shortage of plants. In this case, the grower may have to look at another nursery for plants. Fruit growers will try to follow how chilling is progressing so they know when they may be able to get plants. Some growers deliberately plant later to increase the probability of getting plants with adequate chilling.

The flow of information that takes place between fruit growers and nurseries (and undoubtedly between nurseries) in California is another problem area for a Saskatchewan nursery. It is not only difficult to persuade fruit growers to visit far-away Saskatchewan (although SSPP was able to accomplish this in 2000), but it is difficult to collect from a distance important production and business information about other nurseries that undoubtedly circulates relatively freely within the industry in California.

Given some of the disadvantages a Saskatchewan nursery has relative to California nurseries in terms of the ability to monitor growing and market conditions and service customers, it is important to establishing an open and trusting working relationship with prospective growers. SSPP was especially cognizant of this issue when formulating its marketing strategy and was able to build on the good relationships that had been developed by University of Saskatchewan horticulture and economic researchers in past years.

4.2.2. New Sources of Supply and Price Premiums

As outlined in *Study 2,* the demand and price for strawberry plants is largely a function of how well nursery stock contributes to the profitability of strawberry production. Southern California strawberry growers are known to readily shift to a new strawberry variety if it is shown to provide higher yields of marketable fruit (quantity and quality) and/or reduced costs of production. Similarly, they look for nurseries that can provide superior plants and have shown themselves willing to pay some portion of the extra net returns that such plants provide as a premium to the supplying nursery.

Southern California growers pay a premium for early chilled plants. California nurseries there have responded by moving production to higher elevation and further north, so that some nursery sites are now across the border in Oregon, although their headquarters are still in California and, as far as is known, they are subject to the same regulatory regime as before. If Saskatchewan plants are superior to the best California plants, southern California fruit growers should be willing to pay a larger premium even though produced

at a greater distance away. However, it is a large step for California fruit growers to move to a new supplier as far away as Saskatchewan. Not only is the geographical distance much greater, which raises concerns about timely delivery of a quality product, but regulatory issues are raised by state and international borders that they have not had to deal with before. They are accustomed to purchasing their plants in a well-ordered and insular marketplace and do not wish to deal with any new uncertainties.

There is a precedent for American strawberry fruit growers to look outside the boundaries of their own country for new supplies of superior plants. As discussed in *Study 2,* Florida strawberry growers now obtain approximately 90 percent of their plants from nurseries in Canada (Nova Scotia, Quebec and Ontario) and pay a premium for those plants. They went to Canadian suppliers because the Canadian plants were shown to be more vigorous and relatively disease-free. However, Florida did not have a large nursery industry and had to bring many plants from California prior to the Canadian connection. Some California fruit growers have had experience with Canadian plants also, but unfortunately it has not been positive largely because of regulatory issues.

In Study 2, a price premium was estimated for Saskatchewan plants based on the field trials carried out at Nakama Ranch at Oxnard from January to May 1999 where Saskatchewan-grown plants produced 18 percent more harvested fruit than comparable plants from nurseries in California (see Krieger and Tanino, November 1999). Historical California yield and price data was used to estimate a premium based on this yield advantage.

California strawberry yields for the period 1994 to 1998 averaged 55,600 pounds per acre. 33,360 pounds of this went to the fresh market and 22,240 pounds to the processing market. The study used 1998 weighted average prices for fresh and processing fruit; US $0.872 per pound fresh and US $0.345 per pound for processing. After deducting cooling and palletization costs, the 55,600 pounds provided revenues of US $32,927. Assuming an 18 percent yield increase from the Saskatchewan plants, the revenues would have been US $38,853 per acre, an increase of US $5,926 per acre. The study next

deducted the costs of harvesting the extra fruit leaving a net increase (extra profit) of US $3,364 per acre. If 27,000 plants are planted per acre in southern California then each plant would contribute US $0.125 to extra profit for the California grower.

Study 2 explained that in 1999/2000 California fruit growers were paying US $51 to $61 per thousand plants for the high elevation California-grown nursery stock. These prices were US $6 to $16 per 1000 plants higher than low elevation plants that do not receive early chilling and are deemed to be less vigorous and thus lower yielding. If a Saskatchewan nursery could even capture 20 percent of the estimated added profitability this would add an extra $0.025 per plant, or US $25.00 per thousand plants. This would raise the selling price of Saskatchewan crowns to US $85 to $95 per thousand plants, or about US $0.090 per plant. At a current exchange rate of approximately C $1.50 to US $1.00, this translates into a price of over C $0.13 per plant.

This figure was based on what *Study 2* called the "small market case." In this scenario it was assumed that the increased overall production from using Saskatchewan plants was sufficiently small that the fresh market price for strawberries would not be affected. In the "large market" scenario it was assumed that increased fruit production from southern California would temper the increased profits contributed by Saskatchewan plants. In this case Saskatchewan plants should attract a premium of about US $22 to the selling price of one thousand plants, bringing the selling price to US $73 to $83 per 1000 plants.

The above analysis, combined with the cost of production information in *Study 2,* provided the basis for negotiating a price premium when SSPP approached a number of southern California fruit growers in February 2000 with a proposal to provide them with Saskatchewan plants in the fall of 2000.

4.2.3. California Field Trip: Market Development and Sales Negotiations

One of the key objectives of this ADF project was to "visit California to assess producer interest in Saskatchewan crowns, present one or more demonstration field days in

California in cooperation with California fruit growers who are participating in field trials, and survey growers who attend field days regarding interest in Saskatchewan crowns" (ADF Project Proposal #19990185).

Dr. Gary Storey and James Lokken visited California in late February and early March 2000 to work on this market development research objective. At the same time, the private SSPP partnership that Storey and Lokken were involved in was interested in finding out if there was sufficient interest from California producers in Saskatchewan plants to warrant commercial production in 2000.

Using the contacts developed on previous visits by University of Saskatchewan researchers, the researchers met with major strawberry fruit producers in the Irvine and Oxnard areas, the largest strawberry growing areas in southern California. Individual meetings were held with the three producers who were cooperating in Dr. Tanino's field trials. These producers represented about 1,000 acres of strawberry production. Another five producers from the Oxnard area representing a similar number of acres in total came to a meeting hosted by one of the field trial cooperators, Chas Nakama (see Appendix C) for a list of the producers who attended the meetings). Despite the small number of producers the researchers met with, about twenty per cent of the total strawberry acres in southern California were represented. The number of producers invited to the meeting was kept small on the advice of Chas Nakama who has cooperated with Saskatchewan horticulturalists over several years of field trials and is a prominent grower in Oxnard. He felt that it was not wise to stimulate too much interest in an unproven product and assisted in assembling a group of growers who he felt would assess the potential of the plants seriously and would be willing to risk trying something new.

The researchers agreed that it was important to work with knowledgeable and well-established producers who were leaders in their areas in strawberry production. If these producers became customers for Saskatchewan plants then it would be easier to convince others to follow suit. It was also felt that such experienced producers could provide

useful information for plant production and delivery and perhaps assist with the resolution of any regulatory issues.

The researchers distributed an information package at the meetings. This package included the results from all the previous tests on northern vigour in strawberry plants, a summary of the research on the economic feasibility of producing plants in Saskatchewan and exporting them to California and some promotional information on "visiting Saskatchewan." The latter information was provided to encourage producers to visit Saskatchewan to meet with researchers and tour the research facilities at the University of Saskatchewan and Innovation Place, as well as to inspect SSPP's production site if production occurred in 2000.

After the material in the information package was presented, the producers were sounded out on what they were looking for from a new source of plants, their interest in using Saskatchewan plants given the information they had received, and whether they would consider paying a premium for such plants. SSPP's plans to produce plants in 2000 if sufficient orders were received at an acceptable price provided the mechanism to actually determine the level of interest among these growers and what they were willing to pay for Saskatchewan plants.

In order to set a framework for a discussion of premiums, the growers were presented with the analysis of the potential contribution of northern vigour to their net returns based on the 1999 field trial results at the Nakama Ranch. In addition, a budget for a ten acre commercial operation derived from the *Study 2* material was presented as the basis for determining what price would be necessary for the SSPP operation to break even. The growers did not disagree with either analysis. US $0.09 per plant was suggested by the presenters as the price that SSPP would need to consider production, a premium of 50 percent over the best California high elevation plants. It was explained that there was a great deal of uncertainty for the commercial operation, especially in terms of the number of plants that would be produced. The producers were encouraged to look at this unprecedented price as an investment in a new product. While there was some initial

resistance to the suggested price level, it was obvious that there was a realization that if the plants performed as they had in the Nakama test (18 percent higher production over California plants), the premium would be easily returned. On the other hand, these producers were aware that the Saskatchewan plants were not performing as well in the 2000 trials.

Because of the uncertainty of how many plants could be produced by SSPP, it was decided to ask the growers to specify a minimum and maximum number of plants they would be prepared to purchase. This would give SSPP some leeway in distributing its production among its customers, depending on plant yields.

The first meeting was held with Bill Ito and Steve Ozawa in Irvine who are partners in one of a number of strawberry production operations in which they are each involved. Ito was testing plants for Dr. Tanino at the time. Ito and Ozawa, as the furthest south producers contacted, are the most interested in moving toward earlier planting. As some of the earliest planters in California each fall, they have the best potential to capture the high prices that come with early production. They agreed to purchase a minimum of 100,000 to a maximum of 200,000 plants at the price of US $0.09 per plant. Based on a planting regime of 25,000 plants per acre this would allow them to plant four to eight acres.

Chas Nakama of Oxnard met with the researchers individually and also arranged a meeting with five other producers representing four companies at his office.. The five companies (including Nakama) agreed to purchase a total of 290,000 to 390,000 plants at US $0.09 per plant. Producers at Oxnard do not plant quite as early as those in Irvine and, indeed, vary amongst themselves as to when they plant. However, they, too, are looking at earlier planting dates all of the time.

John Dullam, another of Dr. Tanino's cooperants at Oxnard, met individually with the researchers. He is involved in testing a number of strawberry cultivars, products of both public (university) and private research. He agreed to purchase between 100,000 and 150,000 plants.

In total, the seven customers agreed to purchase between 490,000 and 740,000 plants. Some of the growers said that if SSPP managed to produce more than the maximum number of plants agreed on, they would be prepared to take more plants or would help find other customers. They suggested that high production should warrant a drop in the price of SSPP's plants. However, the researchers pointed out that if the plants performed to the level of the test results, the growers would be receiving a bargain at US $0.09 per plant and SSPP would have an incentive to continue production if it made a profit. It was stated that profitable production would also encourage other growers in Saskatchewan to enter into production.

The presentation of a commercial venture and the negotiation of sales agreements greatly expanded the effect that the demonstration aspect of the ADF project could have achieved otherwise. It can often be counter-productive to inform potential buyers of a product but have no product to sell. In this case, the Saskatchewan representatives were able to provide growers with information on the northern vigour research including the economics of growing plants and also have plants that they could order and test on a field scale level. It was an important accomplishment to deal with some of the largest private growers in the southern California strawberry industry, a number of whom are also public figures in the industry. If they are satisfied with Saskatchewan plants then they will provide the testimonials that will be needed for attracting other customers for a growing Saskatchewan industry. However, it is critical that the expectations created for Saskatchewan plants be met. This means being able to deliver quality plants on a timely basis and that the plants outperform plants from established California nurseries.

In addition to the meetings held in southern California, contacts provided at the California meetings led the researchers further north to the Santa Maria area. There the researchers visited a large conventional producer and an organic producer. According to them, there are many small producers in this area, unlike southern California. Interest was expressed in the attributes of the Saskatchewan plants, although early availability is not an issue, since planting occurs in late October/early November in this region.

Producers in this area buy low elevation plants at about US $0.045 per plant, so the premium demanded for Saskatchewan plants was very high in their opinion, given that they were unsure of the benefits of northern vigour for them.[15] Links should be maintained in this area, however, so that any future market advantage can be identified and exploited. The conventional producer, Jack Gresser, has production interests in Florida also and suggested that he might be interested in testing Saskatchewan plants there sometime in the future.

4.2.4. Provision of Information to Customers

California fruit producers like to monitor the growing conditions at the plant nurseries to help them plan their plant buying strategies and planting schedules. They are in close communications with the nurseries and often visit them personally. Given producers' familiarity with the California nurseries, it was considered to be an extremely important part of the researchers' market development activities to acquaint potential customers not only with the results of the research on northern vigour, but with Saskatchewan in general. A major objective in setting up the California producer meetings was to encourage interested producers to visit Saskatchewan and tour the university, research sites and potential production sites, in particular the Outlook area. The package of information distributed to each producer supported this objective. It included not only summaries of technical material on the northern vigour research and official visitor information but a series of possible visit scenarios of varying lengths prepared by the researchers that included potential itineraries and costs. Producers commented that the researchers were good salesmen for not only northern vigour in strawberry plants but for the tourist attractions of Saskatchewan!

Following the negotiation of sales of plants in February/March 2000, SSPP was very careful to keep in contact with its customers by letter and telephone over the summer informing them of the progress of plant development in Saskatchewan and other business

[15] No tests of Saskatchewan plants have been carried out in this area.

issues. The customers remained very friendly and interested in the Saskatchewan situation.

In mid-September, Bill Ito and Steve Ozawa, the customers with the largest order, flew to Saskatoon from Los Angeles, arriving on Saturday evening and leaving on Monday afternoon. They visited the Pike Lake production site and toured the University buildings and research plots where they met with strawberry researchers. Dr. Karen Tanino outlined her research on northern vigour. Dr. Robert Bors showed them his strawberry plots and informed them of his research plans for developing new strawberry cultivars. They were surprised to find a dedicated strawberry breeder at the University of Saskatchewan.

The short visit did not enable Ito and Ozawa to see much more of Saskatchewan than the University and the Pike Lake site, but they did visit the Western Development Museum. The growers paid for their own airfares and hotel accommodations; SSPP paid for entertainment, meals and local transportation. Chas Nakama had also planned to visit Saskatchewan but due to problems in getting his fields prepared for planting had to cancel his trip.

Ito and Ozawa had a generally favourable reaction to the production site. They were impressed with the nursery sanitation in terms of weeds and visible pests or pest damage, especially when they heard that no pesticides had been used. The double row planting regime used, which left about forty percent of the field bare, surprised them. Nurseries in California allow plants to spread across the entire field. They felt that many of the secondary daughter plants were too small and had too little root development to market. SSPP, while taking this observation seriously, was aware that this is a negotiating issue between buyer and sellers.[16]

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[16] The issue of crown size is always a contentious issue between nurseries and fruit growers. Growers tend to want all large crowns while nurseries want to sell as much product as possible. SSPP's inexperience regarding the issue of crown size had a heavy cost at harvest time (see Section 3.3.1.a.).

Ito and Ozawa are very interested in moving their planting dates to mid-September or even earlier from the current late September-early October planting period at their location in Irvine, south of Los Angeles. They wanted a box of plants as soon as possible (they would have taken one with them if they could have). A box of plants was harvested and sent by air immediately after they left, but difficulty at customs prevented its delivery and another attempt was not made because the positive nematode results had been received by that time and the occurrence of any harvest at all was in question (see Sections 5.2.1 and 5.2.2.f.).

4.2.5. Plant Delivery

Southern California fruit growers want plants delivered as soon after digging as possible. They are used to receiving them from northern California within three days of harvest and believe the plants begin to deteriorate if this period is much longer. However, fully chilled strawberry plants are stored for months at a time before planting and it should be possible to store even the early dug plants for considerable periods of time. It is not possible to supply plants as quickly as the customers would like from Saskatchewan. The shortest reasonable time frame from harvest to delivery for Saskatchewan plants (unless the industry becomes quite large) is likely close to one week, even with very efficient operations (of course the last packed plants in any truckload will be out of the ground for a shorter interval). The longest-harvested plants in the SSPP truckload had been out of the ground for ten days by delivery time. The Saskatchewan product will have to be highly desired by California customers and will have to arrive in California in very good condition in order to compete with California plants.

The problems associated with harvesting and packaging the plants (nematode testing, frost, slow processing) are explained in detail in section 3.3.1.c. When harvest was finally begun one week later than planned, the customers were informed that only the second of the two planned shipments would take place, arriving in the second week of October. As the processing week proceeded it became apparent that the number of plants that could be harvested in the abbreviated time frame had to be reduced. Again the

customers were contacted to arrange reductions in their orders. John Dullam had already reduced his order in August from a maximum of 150,000 plants to 14,000 plants. Cal Sun, where there had been a change in management, had been showing some reluctance to take plants so that order was cancelled. Ito and Ozawa would be basically finished planting by the time the plants could be delivered. Their objective of securing some early plants could not be met so their order was reduced to its minimum of 100,000. Other customers agreed to varying reductions and Chas Nakama agreed to take whatever SSPP could send since it would not be clear until the end of the week how many plants had actually been packed.

In total, 305,000 plants left by refrigerated transport on Sunday, October 8, 2000. Gary Storey flew to Los Angeles the same day in order to be there when the plants arrived so he could check the condition of the plants and deal with any difficulties that might ensue. The trucker carried a cellular telephone so it was possible to contact him and vice versa in case problems developed *en route*, either mechanical or with inspection at the borders (the border requirements are provided in Section 5.2).

The trucker entered the United States at the Coutts, Alberta/Sweetgrass, Montana border crossing and traveled through Utah and Nevada before entering California. He did not encounter major problems at the international or state border. Some of the customs broker's paper work had to be redone at Sweetgrass because it was not filled out correctly, which delayed the truck slightly. The load was not inspected by US Customs. At the California border, a quarantine order subject to county inspectors' discretion was placed on the shipment, as expected.

The truck arrived at the location for Ito/ Ozawa's delivery, Magarro Farm's cooler in Irvine, at approximately 3:00 a.m. on Wednesday, October 11. Storey met the trucker at 5:00 a.m. at the cooler. 100,000 were off-loaded into the cooler when it opened at 5:30 a.m. and the Orange county inspector was informed that the plants had arrived (previous arrangements had been made to have the inspection take place in the cooler). The truck, with Storey following in a car, left for Oxnard at 6:00 a.m., before the inspector arrived,

but the plants were inspected promptly and with no difficulties. Ito/Ozawa then moved them to their operation for immediate planting.

When the truck was within one hour of Oxnard, the trucker called the chief inspector for Ventura County giving him the time and place of arrival. An inspector arrived at the CalSun cooler minutes after the truck arrived. He opened one box and inspected the plants. He said that they looked fine and released the entire load. The plants for three of the growers, Dullam, Carter and Nakamura were unloaded at Cal Sun and the growers were notified. The plants for Nakama and Doyle were delivered to the Nakama operation.

Several boxes of plants were opened upon unloading at Nakama Ranch and inspected . Chas Nakama thought they looked in reasonable condition, although possibly a little too moist, especially toward the bottom of the box. Within 15 minutes of being unloaded the plants were taken to the field for planting. Nakama and Storey went to the field about 30 minutes later when the workers were already almost finished putting in 50,000 plants. The foreman expressed concern about some plants that were at the bottom of one box. These plants were grayish in colour and looked as if they may have heated. They definitely were not healthy. The problem had not been noted until almost all of the plants had been planted and it was not known how extensive the problem was. The labourers who do the planting do not pay much attention to the quality of the plants - they simply open boxes, lay the plants out on the raised beds and plant them as quickly a possible.

Nakama was quite concerned that something was seriously wrong with at least some of the plants. Based on his years of experience he was certain that a high percentage of any plants in this condition would not survive. Storey immediately called the other customers, informed them of the potential problem and asked them to inspect the plants carefully, especially toward the bottoms of the boxes.

Ito/Ozawa were called first as they had received their plants much earlier in the day. They had already planted 50,000 of the plants, and were going to plant the other 50,000

the next morning. No problem had been noted with the plants, but after an inspection, they could see there were some problems. They decided to put the remaining 50,000 plants in trays with water and use the good ones for general field replacements.

Each customer treated the situation differently. One grower checked the plants, felt there was no problem and planted them all. A visit was made to his fields just as they were finishing planting the Saskatchewan plants. The remaining boxes seemed fine except for one box, which had some plants that were out of condition in the bottom. Another customer had planted most of the plants shortly after they were received. In this case the field manager saved some of the plants that he felt did not look healthy.

One customer (Nakamura) carefully screened all the boxes and did not plant the plants that looked "heated". This amounted to about seven boxes (10,000 plants) or 25 percent of the plants received. This turned out to be the best approach as this grower had few plant losses in the field and the plants performed the best of all of the Saskatchewan plants in 2000.

A detailed discussion of the damaged plant problem is found in Section 3.3.1.c. The customers, on the whole, while very disappointed, were very reasonable about the problems with SSPP's plants. The number of SSPP plants they had ordered was small in relation to the size of their operations (less than two percent in each case) and they conceded that even well-established nurseries can have problems. In addition, there was a surplus of plants from the California nurseries in 2000, so it was not as difficult as it might have been to deal with the reduced number of plants delivered or with the loss of plants in the field. Their patience indicates their interest in the Saskatchewan product. On the other hand, the problems associated with getting plants from Saskatchewan in 2000 confirmed the fruit producers' earlier stated concerns with the ability of a nursery at a distance and across borders to supply quality plants consistently.

4.2.6. Payment

In order to secure commitment from customers, California nurseries often send invoices for a percentage of the value of the plants for which they have orders soon after they have planted their nursery crops. They sometimes invoice the customers again later in the summer for another percentage of the value of the plants. SSPP had been warned (by some customers) that some growers actually pay the deposits while other growers do not. Many growers want to make sure that they, in fact, receive the plants in good condition and that they do not die in the field before any money is paid. However, this can be a risky strategy in years where there are shortages of plants, since the nurseries will fill the orders with deposits paid first.

SSPP invoiced each grower in May for a ten percent deposit on the maximum number of plants ordered. Over the next three months, four out of seven SSPP customers remitted the full invoiced amount, while one sent in a ten percent deposit on an order cut from a maximum of 150,000 plants to 14,000 plants because of changes in business plans. Two customers did not send deposits but still wanted plants.

It is customary for customers to make final payment on receipt of the plants or within three weeks if they are concerned about the health of the plants. If plants are going to die it is likely to take occur within three weeks. Damaged crowns that are planted can still produce leaves. The plant can in fact look quite healthy for a time and then die. What happens is that the plant has sufficient stored nutrients to produce leaves even when new root hairs fail to develop. When the stored energy is dissipated and with no new roots the plant will wither and die.

Fruit growers will accept a one to three percent plant loss. If the loss is greater than this they are likely to adjust the payment accordingly. For greater losses it is possible that the grower may decide not make payment at all. Plant losses are very costly for the producer. First, there are the labour and other costs of replacing the dead plant. Second, an unevenly growing field affects yield and the cost of picking.

In the case of the Saskatchewan plants it was not clear after the problems were discovered what the result would be. It was agreed that payment would not be expected until well into fruit harvest to allow a proper assessment of the damage and adjustment of the payment. Each customer was told a Saskatchewan representative (likely Storey) would visit sometime in late February or early March, 2001 to see how the plants were performing.

Three weeks after planting the customers reported death losses from 15 to 40 percent, except for the one grower, Nakamura, who had culled before planting and lost almost no plants. Frequent telephone contact was maintained with the customers throughout the winter and Storey visited, as promised, in March 2001. Every customer made a final payment. The payment was based on the customer's own estimates of plant survival. The overall average of the plants paid for was about 72 percent of the plants delivered. Two customers paid about one month after delivery while the rest paid Storey during the March visit or shortly thereafter.

4.3. Overall Results

In late June 2001 all of the growers who had received Saskatchewan plants were surveyed by telephone. Each grower was asked for information on:

- overall production in 2001 compared to an average year;
- how the Saskatchewan plants had performed compared to plants from other nurseries, and who those nurseries were;
- what the quality of the Saskatchewan fruit was compared to other nurseries;
- other comments on Saskatchewan plants; and,
- if they would be willing to purchase Saskatchewan plants in the future.

4.3.1. The 2001 Fruit Production Season

It was a mixed production year in southern California. Orange county and Oxnard had very wet weather in February and early March. Most growers agreed that they were down about 600 to 1000 trays of fresh fruit per acre from an average year. Where they would normally get 4000 trays they were getting around 3000 to 3400 trays. This reduction was caused by fruit rot so that none of the damaged fruit was even suitable for processing. The offsetting factor was that in 2001 they were able to market more processing fruit later in the season as the price of processing fruit remained higher than in 2000.

4.3.2. Yield and Quality Comparisons

Most of the SSPP customers said in the June interview, as they did at the time of the Feb/March visit, that the quality of California-grown nursery plants was excellent in 2001. In fact, they were some of the best plants that had been seen in years. They had good chilling and had larger than normal crown size. The California producers, themselves, said it was a difficult year to do a fair comparison with either the SSPP plants or the test plants sent from various locations in Saskatchewan and Alberta by Dr. Tanino.

4.3.2.a. SSPP Plants

One difficulty in doing a proper comparison of the SSPP plants and California-grown plants was that, in most cases, the SSPP plants that died were replaced with California plants. This meant that the fields were a mixture of plants. In addition, the replacement plants fruited later and did not yield as well. There were two exceptions. Ito/Ozawa in Orange County did use SSPP plants for replacement and the Nakamuras had a very small die out of SSPP plants because they culled heavily before planting.

All of the growers with the exception of the Nakamuras said that their best estimate would be that the SSPP plants yielded about the same as comparison California plants. They also felt that the quality of the fruit was about the same. Unfortunately, none of the

growers with the exception of the Nakamuras did a systematic field comparison, actually weighing fruit from several rows, and Nakamuras only did so for one month. Ito/Ozawa were unable to provide a comparison because the fields where the SSPP plants were located were infected with white flies. These insects, which came from a nearby field of tomatoes, laid eggs in the strawberry leaves and the larvae attacked the fruit. The overall yield in the field was thought to have been reduced by about 25 percent.

The Nakamuras were the only growers with a solid planting of SSPP plants all planted at the same time. At the time of the March visit, the two areas at the Nakamura farm with SSPP plants looked to be in excellent condition. The SSPP plants were more advanced than the comparison plants from the high elevation nurseries at McDoell, which are some of the highest quality plants available. In March, the Nakamuras were not ready to state that SSPP plants were yielding more, but by June they believed that the SSPP plants had yielded perhaps ten percent more. They were pleased with the Saskatchewan plants. They said that the foremen who managed the two sites where the Saskatchewan plants were grown asked, "where did these plants come from?" and recommended getting more of them in future years.

4.3.2.b. University Trials

Dr. Tanino of the University of Sasakatchewan carried out field testing of 'Camarosa' nursery plants from various locations in Saskatchewan and Alberta during the 2000/2001 season at the Nakama and Ito farms in southern California. The data on yield and fruit size from these tests had not been fully analyzed by the horticultural researchers at the time of submission of this report. However, preliminary results show the Canadian plants produced less fruit than the California plants in 2001. The high quality of the California plants in the fall of 2000, chilling differences between Canadian and American plants, problems with harvesting and processing of some of the Canadian plants and the difficult weather during the fruiting season may have had an impact on the relative yields.

The data and analysis from the 1999/2000 field trials of Saskatchewan-grown plants can be found in Krieger and Tanino (November 2000). Those trial results were less favourable than the very encouraging 1998/1999 field trials and the plot trials of previous years on which SSPP had based its business projections. (Krieger and Tanino, November 1999). In the 1999/2000 trials there was only one location in southern California where the Saskatchewan plants had comparable yields to California sourced plants. At the other locations the Saskatchewan plants had substantially lower yields. The mixed results from the field testing of Saskatchewan plants over the last three years suggest that there is a need for more testing and evaluation before commercial production is pursued on a large scale in Saskatchewan.

4.3.3. Future Purchases

All of the SSPP customers said that they would be prepared to try Saskatchewan-grown plants again. They believe that plants grown in Saskatchewan, given the higher latitude, should have natural advantages over California grown plants. However, they want assurances that the mistakes that were made in packaging and shipping in 2001 will be rectified. (Section 3.3.1.c. provides details of the likely sources of SSPP's processing problems and some potential solutions.)

4.3.3.a. Early Planting

The customers are in agreement that they want to be able to plant earlier. They want to be able to get into the higher priced December/early January market that is currently dominated by Florida. If Saskatchewan plants consistently have more chilling by mid-September than high elevation California plants, they will have a tremendous market appeal.

4.3.3.b. Timing of Delivery

The customers caution that California nurseries have one key advantage over a Saskatchewan nursery – close proximity. The growers are suspicious of plants that are dug and kept in storage. They believe that any but the briefest period of storage is detrimental to vigour and survival in early-dug plants. Their experience in 2000 with the spoiled Saskatchewan plants only reinforces this concern. Until they are given proof to the contrary, both scientific and practical, Saskatchewan strawberry nurseries will need to come close to California nurseries in minimizing the time between digging and planting. This will mean making frequent shipments even if they are not full loads. This problem can be partially overcome if there is production on a large enough scale in Saskatchewan. If several nurseries were to ship cooperatively, loaded trucks can be sent frequently. This is done in Nova Scotia for plants going to Florida. However, Saskatchewan will have difficulty matching the delivery time of the California nurseries.

4.3.3.c. Methyl Bromide

One of the big uncertainties facing the strawberry industry in California and Florida is the impact of not being able to fumigate with methyl bromide. This is one of the reasons that there is interest in Saskatchewan plants. There are other fumigants available but they are not considered to be as effective. Chas Nakama, the SSPP customer with the most experience, is the most concerned. He remembers other chemical treatments prior to methyl bromide that were not as effective. If disease and pest -free plants can be grown in Saskatchewan without fumigation, or at least without methyl bromide, this may provide Saskatchewan with a tremendous advantage over California nurseries.

It is possible that another chemical can be found to effectively replace methyl bromide or that some combination of current chemicals will prove to be as effective, but this is highly uncertain at this time.

Section 5. Licensing, Regulations and Inspection

This section discusses the various licensing, regulatory and inspection requirements that govern the production, movement and sale of strawberry nursery plants destined for use in fruit production in California.[17] Satisfying these requirements was identified in *Study 2* as one of the biggest potential constraints to successful strawberry plant production in Saskatchewan for the California market. This proved to be the case for SSPP in its inaugural year. Meeting United States Department of Agriculture (USDA) requirements for export into the United States was not difficult given the assistance of the Canadian Food Inspection Agency (CFIA). However, the California Department of Food and Agriculture (CDFA) has a variety of production and plant transfer rules of its own. These regulations create so much uncertainty and risk for a Saskatchewan producer/exporter that they may make an industry based on sales to California untenable unless the uncertainty can be eliminated.

There were times during 2000 that licensing, regulatory and inspection difficulties put the entire SSPP enterprise at risk. First, there was a question whether SSPP would receive the required production license from the University of California (the owner of the 'Camarosa' patent) in time to purchase registered 'Camarosa' plants for spring planting in 2000. Later, the discovery of nematodes in the SSPP plants prior to harvest almost prevented the export of any plants to California in the fall of 2000. The time taken to resolve this issue delayed harvest and processing to the extent that customer orders for plants could only be partially filled because it was not possible to finish harvesting within the customers' planting window in California. Almost one third of the plants remained unharvested. Also because the harvest was delayed, a series of heavy frosts damaged a large percentage of the plants that would otherwise have been harvested prior to the

[17] While the following descriptions of regulations and requirements are extensive, they are only commentary and may be incomplete, inaccurate or outdated. Readers who need to know the exact requirements should consult the original sources.

frosts. Because the damage was undetected, the damaged plants were shipped and there was a resulting heavy loss of plants in the field in California. SSPP's revenues were reduced because the customers only paid for the plants that survived.

Since there is no inspection and certification system in Saskatchewan for strawberry plants, SSPP developed an inspection regime with the cooperation of the CFIA and Saskatchewan Agriculture and Food (SAF) based on California's requirements for certification, nursery sanitation and nematode control. This *ad hoc* inspection and certification regime helped to get the SSPP plants through all of the regulatory "hoops" in 2000 but such a system cannot be depended on in future years.

As things stand now, no matter what regulations and inspection regime plants are subjected to in Saskatchewan, plants exported to California must be approved by inspectors at the county level in California before they can be distributed to customers. After all the production, processing and transport costs have been incurred by the producer, there is a possibility that a shipment could be refused by county inspectors and sent out of California or that a quarantine order could be placed on a shipment.[18] Even if the plants were released for sale after such a quarantine period, customers likely would not accept them because of the long storage period or because the planting window had passed. California nurseries in good standing with the regulatory authorities avoid this problem because their products are exempt from county inspection (refer to Section 5.2.2.c.). Each box of California nursery plants is stamped with a notice that reads "need not be held for inspection in California."

To solve this problem, Saskatchewan production methods and pest control techniques will have to be subject to an official inspection system that meets CDFA standards and is officially recognized by California regulators. The CDFA certification regulations allow for second party certification in certain instances. It may be possible to use this

[18] A quarantine order would remain in effect for as long as it took to test and clear the plants for whatever problem was suspected. If nematodes were suspected, the laboratory tests required would take more than one week.

regulatory provision to bring production in Saskatchewan within the California system. The authors believe that there must be direct communication between SAF and CDFA if the regulatory risk is to be lessened. The CFIA will not normally get involved in trade issues that arise from state level regulations (Lemmon, personal communication, 2000).

5.1. Licensing

Many of the strawberry varieties used for commercial fruit production in North America are patented and cannot be grown without a license from the patent holder and the payment of royalties. There are varieties available that never were patented or where the patent has expired, but patented varieties dominate the market more and more in the United States. The University of California holds the patent on a number of popular varieties, including 'Camarosa' which, in the last five years, has become almost the sole variety used for strawberry fruit production in southern California. It is also used extensively in Florida.

New patented varieties from the University of California are expected to be released in the near future. If these varieties are commercially successful, the first nurseries that move into production likely will reap the greatest benefits. The University of California supplies California nurseries with newly released strawberry varieties two years before out-of-state nurseries are able to access the material. This could be a serious problem for Saskatchewan nurseries if there is a repeat of the rapid and widespread adoption of Camarosa in southern California in the late 1990's. Saskatchewan nurseries could be left for a period of time with the ability to produce only varieties that have fallen out of favour while the California nurseries capitalize on the demand for a new variety. This is a risk that must be factored into future plans for plant production in Saskatchewan. Equal access to new California varieties must be sought either through regulatory changes in California or through business arrangements with California nurseries or fruit producers. Another strategy is for Saskatchewan to develop its own varieties that would be attractive to California growers. This may be possible since there is now a strawberry breeder at

the University of Saskatchewan (Dr. Robert Bors). Developing markets outside of southern California also can be important in reducing the risk of production in Saskatchewan.

5.1.1. License Application

SSPP decided to concentrate in its first year of production on producing certified 'Camarosa' plants because of that variety's predominance in the southern California market. In order to obtain registered 'Camarosa' plants and propagate them, a license had to be obtained from the University of California's Office of Technology Transfer (OTT). This license confers the right to purchase plant material of the cultivar 'Camarosa' for propagation and transfer within Canada and the United States, limited by a variety of conditions imposed in the license.[19] In 2000, the license cost US $50.00 per variety licensed.

The licensing process can take some time to complete. SSPP began the process of applying for the right to multiply 'Camarosa' plants in December 1999, even before the SSPP partnership had been officially created. At that time, the OTT was going through a process of rewriting all of the existing license agreements with nurseries and distributors. Because of this, the Strawberry Licensing Specialist at OTT initially thought it might take up to six months to issue SSPP a license. However, when the importance of receiving a license early enough to be able to plant in May of 2000 was conveyed, the OTT was very cooperative in accelerating the process.

The finalized agreement was received by SSPP on April 5, 2000. Registered plants used for propagation usually cannot be purchased without a license. However, verbal assurance had been received from the OTT that it was permissable to order registered plants before the licensing process was complete. Both California nurseries with which

[19]The license application form and supporting information can be found on the Office of Technology Transfer's internet site at http://www.ucop.edu/ott/strawberry/. The conditions of each license are specific to each particular agreement between the OTT and a nursery and are confidential. Only the general

SSPP was dealing, Lassen Canyon and NorCal, were informed of this by the OTT. The plants were ordered in March 2000 on the basis of this verbal assurance.

5.1.2. License Conditions

The license is an agreement between the Regents of the University of California and Saskatchewan Strawberry Plant Producers. The license regulates the asexual propagation and transfer of all plants and plant parts of the cultivar 'Camarosa'. It allows SSPP to obtain 'Camarosa' plant material for the purposes of asexual propagation. SSPP can then transfer the products of this propagation to other licensed nurseries and to authorized fruit growers in the United States and Canada only. The patent on 'Camarosa' expires in 2013. The license is in force until the expiration of the patent or until the OTT and SSPP agree to terminate it.

5.1.3. Royalty Payments

Royalty fees are incurred when planting material is transferred to growers for fruit production. Transfer refers to any movement of plants to fruit growers whether a sale, gift, rental or loan. The licensee is responsible for paying the royalty fees whether or not they are collected from customers. The OTT should be contacted for more information on royalty fees.

Plant material can be transferred between licensed nurseries without royalty payments. For instance, there was no royalty payment required when SSPP purchased plants from Lassen Canyon or NorCal for propagation.

The licensee is responsible for remitting royalty payments and royalty reports according to a required schedule. The onus is on licensees to ensure that they only make transfers

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conditions of a license are presented in this section because of this requirement for confidentiality. For current accurate information, the OTT should be contacted directly.

to authorized customers. Licensees must keep detailed records and the OTT reserves the right to inspect production and processing premises.

5.1.4. Labeling

All licensed products or their containers that are transferred by a licensee must specify the correct name of the licensed cultivar and the corresponding patent numbers (Appendix B).

5.2. Regulations

5.2.1. United States Department of Agriculture (USDA) Regulations

A permit from the United States government is not required to export bareroot strawberry plants into the United States from Canada (USDA 1996). The plants, however, must be accompanied by a phytosanitary certificate from the CFIA, a commercial invoice, a customs invoice and a NAFTA Certificate of Origin. The last two should be completed with the assistance of a customs broker since it is easy to fill them out incorrectly. Boxes must be clearly labeled with the contents and the name and address of the shipper (Appendix B). SSPP had to make several telephone calls to various departments of the USDA and US Customs to confirm that these were the only import requirements. It is wise to contact both the US Customs and USDA officers at the port of entry before any product appears at the border to make sure that they understand the requirements for entry and know the shipment is coming. A US customs broker must be used to clear material through customs as the following description illustrates.

In past years, University of Saskatchewan researchers have sent strawberry plants by air courier to California. The couriers do not keep the plants cool and the plants have often arrived in poor condition after delays. In 2000, SSPP had a request from a customer to ship a box of plants by air before the main harvest began. In an attempt to avoid the problem of poor courier service, SSPP sent this box to Los Angeles using Air Canada's

guaranteed refrigeration service. The box was accompanied by a phytosanitary certificate and the appropriate customs documents but there was no designated customs broker. US Customs would not release the box to the customer unless a bonded carrier took it for inspection to a separate USDA building, even though USDA inspectors regularly visited the cooler where it was being held. This transfer would have cost about US $200, much more than the value of the plants. The courier companies apparently offer this brokerage and bonded service as part of their fee. After several days of fruitless telephone negotiations, SSPP finally had the box returned to Saskatoon, much to the disappointment and inconvenience of the customer. A research opportunity was lost because this box of plants was going to be used for testing the vigour of early-dug plants. It is possible that USDA officials were acting on behalf of California state inspectors by insisting that the box had to be moved to a different site for inspection.

In order to avoid such a problem again, US Customs and USDA officials were notified before the main SSPP shipment arrived by truck at the Coutts, Alberta/Sweetgrass, Montana border crossing two weeks later. The truck was not opened for inspection. However, the trucker discovered that the customs broker had not filled out some of the forms properly. He had to get them changed before crossing the border.

5.2.2. California Regulations

Agricultural production in California and imports of agricultural products are subject to the requirements of *California Food and Agricultural Code*. An important part of the code is the control of insect or animal pests, plant diseases and noxious weeds. Many of the regulations to which Saskatchewan strawberry plants are subject when entering California are connected to this effort to control pest organisms.

Section 403 of the *California Food and Agricultural Code* states that "the department (CDFA) shall prevent the introduction and spread of injurious insect or animal pests, plant diseases, and noxious weeds." The CDFA determines the level of pest prevention action it undertakes based on pest ratings which rate the potential and actual harm an

organism might cause to California's agriculture and environment. These actions can range from enforced "eradication, quarantine, regulation, containment, rejection, or other holding action" for organisms of known economic importance, to no action for organisms considered to be of no economic importance (CDFA 1993).

It is possible that California could use its concerns about pest organisms as grounds for preventing the entry of agricultural products that may compete with its own production. Saskatchewan strawberry plant producers will have to ensure that they understand and can satisfy the California regulations, so that competing California nurseries cannot use these regulations to block trade in plants.

5.2.2.a. Out-of-State Nursery Plant Material

California has a variety of regulations that control the production and movement of strawberry nursery plants within the state. Plants from outside the state have not been produced within this system of regulation and inspection. This does not prevent their entry into the state. Instead, California accepts out-of-state plants on a case-by-case basis, depending on the results of inspection at the county level. While CDFA officials at the Pest Exclusion Branch in Sacramento willingly provide any requested information on state regulations regarding strawberry plants, they are non-committal about the acceptability of out-of-state plants, leaving the decision up to the discretion of county inspectors. This creates much uncertainty for an out-of-state plant producer.

Trucks carrying strawberry plants into California must report to state border inspection stations where they may be subject to inspection. The usual course of events is that no inspection takes place at that time, but a quarantine order subject to county inspection is faxed ahead to the inspection offices of the destination counties. The truck then moves on to its destination(s). The material must be inspected by county inspectors before it is released to customers. The decision to allow entry to the shipment is left to the county inspectors. If there are concerns with the material it may be rejected and sent out of the state or it may be placed under quarantine until it has been tested for the suspected or

5.2.2.b. Certification

California has a certification hierarchy for strawberry plant material that begins with nuclear stock and moves through foundation, registered and certified to common stock. The regulations defining each of these classes of plant material and governing their production and marketing are found in the CDFA's *Regulations for California Certified Strawberry Plants.*

Commercial nurseries are in the business of propagating plants of one classification from plants of the next higher classification. Large nurseries in California produce registered plants from foundation plants for sale to other propagating nurseries and also produce certified plants from registered plants for sale to fruit growers or for further multiplication at high elevation nurseries (Ogden, personal communication, 2001. They may also multiply plant material at higher levels for patent holders or for their own research.

According to CDFA regulations, only first year daughter plants of registered plants are eligible to be certified as certified plants. If registered plants are left to produce new plants a second year or if the first year daughter plants are multiplied again, the resulting plants are considered common stock. According to the CDFA, much of the high elevation plant material used for fruit production in southern California is actually common stock that originated in the certification program (Baca, personal communication, 2000).

SSPP produced certified level plants from registered plants for its customers in 2000 because it understood that this was the level required by its customers. This may not be the case. If further production occurs in Saskatchewan, this issue will have to be resolved.

SSPP ordered registered plant material from the two largest plant nurseries in California, Lassen Canyon and NorCal. These nurseries generally have good reputations among SSPP's customers. They are also familiar with selling to customers in Eastern Canada.

SSPP wanted to compare the quality of plants provided by these nurseries and observe how they handled and shipped product. It was also important to purchase plants from more than one source to be able to negotiate on price.

SSPP followed as closely as possible the requirements for certified production found in the California regulations. Copies of these regulations were provided to the CFIA and SAF and to University of Saskatchewan strawberry production and pest specialists. The production field was inspected twice by personnel from each of these groups. However, there was no mechanism to undergo the official California certification inspection procedure. It is possible that this could occur in the future given the provision in the CDFA regulations for certification by a second party (CDFA 1984).

Since there is no official Saskatchewan certification system in existence at this time, the boxes of plants that were shipped to the United States were labeled "propagated from California Registered Stock." rather than labeled "Certified". To insure that the production, inspection and labeling regime followed by SSPP was acceptable to California regulators, it was explained in detail in telephone conversations with the appropriate California state officials and with county officials in each of the counties to which SSPP was shipping plants. There did not seem to be any problem with accepting the SSPP plants as equivalent to California certified plants by customers or state officials.

5.2.2.c. Nursery Sanitation

Producers and sellers of nursery stock in California are required to comply with the standards of cleanliness and degree of control of insect, animal and weed pests and disease set out in the CDFA's *Regulations for Nursery Inspection.* Nurseries can be inspected by county agricultural inspectors and nursery products can be held for inspection when moving between counties in California. Strawberry plant nurseries that comply with the regulations regarding pest control and sanitation receive the right to place Nursery Stock Certificates on their shipping packages that state that the shipment "need not be held for inspection in California." The Nursery Stock Certificate allows

free movement of the certified material, which speeds up the transfer between plant growers and customers and eliminates the risk of plants being placed in quarantine after shipment. Some of the nursery material actually originates from nurseries in southern Oregon, but is accepted as California stock because of the similarity of production requirements in Oregon and the fact that the nurseries there are integral parts of California operations (Ogden, personal communication 2001). The plants from Oregon are processed in California for the most part.

Access to such certification for a Saskatchewan strawberry plant grower through business arrangements with California firms or agreement with the government of California would dramatically reduce risk, since it is the exposure to the possibility of quarantine with each shipment and at each county destination that makes the export of plants to California so risky.

In 2000, Clarence Peters, SAF fruit development specialist, issued Nursery Stock Inspection Certificates from the Province of Saskatchewan which accompanied the SSPP shipments to California (Appendix B). Of course, there was no ability to include the statement that the plants "need not be held for inspection in California," but the certificates indicated that there was public regulatory input into the production and export of SSPP's plants.

Fumigation is used by most strawberry plant producers as the initial and, perhaps, the most important tool to achieve a clean nursery. The advantages and disadvantages of fumigation are discussed extensively in *Study 2*. While control of nematodes is the primary reason for fumigation, fumigation before each production season also provides control of soil-borne diseases, insects and other animal pests as well as providing initial weed control. SSPP did not fumigate for a number of reasons:

- Arranging the expertise, material and machinery to fumigate in the short time period between start-up of the SSPP operation and the beginning of planting did not seem possible.

- Fumigation is very costly, although this cost may be partially offset by a reduction in the manual weeding expense.

- Nematode tests in 1999 of various test plots in Saskatchewan where strawberry plants had been grown showed almost no nematodes to be present.

- If strawberry plants could be produced successfully without fumigation in Saskatchewan, an industry here may have an advantage in the future since California nurseries will probably lose the right to use their major fumigant, methyl bromide, in the next few years. The California industry has not found adequate replacement fumigants for methyl bromide to date, but the California Strawberry Commission has made this research a priority (California Strawberry Commission internet site, 2001).

While there were good reasons not to fumigate, this decision may have been very costly for SSPP. The nematodes found in the 2000 crop could have been eradicated with a pre-planting fumigation if they were resident in the soil at the Pike Lake location. However, it is possible that the nematodes came with the registered stock purchased from California, in which case pre-planting fumigation would not have helped. Further analysis and testing must be targeted toward the fumigation and nematode control issue. There are strawberry fruit producers in Saskatchewan who do fumigate before planting. Their input into solving this issue should be sought.

5.2.2.d. Disease and Insect Pest Control

Nursery stock must be kept essentially free of disease and insect or other animal pests through removal of affected plants, the use of chemical controls or other pest management techniques. SSPP did not need to use any disease or insect pest control measures in 2000. Damage to plants that was visible during field inspections was determined to be from wind or nutrient deficiency. Plant samples were tested in the

provincial laboratory in Regina and found to be free of mites or other pests. The California customers who inspected the SSPP field in September 2000 were impressed with the health of the plants. They seemed particularly concerned about the possibility of cyclamen mites, but seemed satisfied that there were none. In future years of production, a more rigorous pest and disease testing regime should be developed, based on both knowledge of local pest and disease problems and knowledge of California's concerns in this area. As long as nursery material comes in from California, there is a potential for pest and disease problems to be imported.

5.2.2.e. Weed Control

California has an extensive list of noxious weeds. This list can be found on the CDFA internet site under *Encycloweedia: Notes on Identification, Biology and Management of Plants Defined as Noxious Weeds by California Law.*

Herbicides are not used for weed control in strawberry plant production. The only chemical weed control generally used is pre-planting fumigation. Fruit grower customers of nurseries are very concerned that herbicides may affect the future growth and productivity of plants. A great deal of effort and money was expended by SSPP in manually controlling weeds in 2000. The California customers who inspected the SSPP field in September 2000 were very pleased with the weed control. In future years, the weed populations and weed control history of a field must be among the most important determinants of its suitability for strawberry plant production. Saskatchewan producers must observe what level of weed control is achieved in nurseries in California and match this.

5.2.2.f. Nematode Control

California considers nematode control to be a very serious issue. It has a lengthy nematode pest rating list that rates over one hundred nematode species by their economic importance and according to the actions which must be taken to control them. These

actions can range from enforced "eradication, quarantine, regulation, containment, rejection, or other holding action" for organisms of known economic importance, to "no action" for organisms considered to be of no economic importance (CDFA 1993).

Nematodes in nurseries are controlled through a Nursery Stock Nematode Certification program. Nursery stock for farm planting must "be commercially clean with respect to economically important nematode species detrimental to agriculture" (CDFA, June 1998a). Commercially clean means that " pests are under effective control, are present only to a light degree, and that only a few of the plants in any lot or block of nursery stock or on the premises show any infestation or infection, and none of these show more than a few individuals of any insect, animal or weed pests, or more than a few individual infestations of any plant disease" (CDFA 1996).

Nematode cleanliness certification is achieved either by using an approved soil treatment (i.e. fumigation according to a prescribed regime) or laboratory testing for nematode cleanliness using a prescribed field sampling technique and prescribed laboratory methods for extracting nematodes (Appendix A).

SSPP, naively in retrospect, did not think that nematodes would be an issue for Saskatchewan-grown plants and that sampling for nematodes was simply a regulatory step that was a necessary formality. In late August, 2000, the SSPP field was sampled according to the California protocol in the documented presence of CFIA, SAF and university personnel. The samples were submitted for testing to the Pest Diagnostic Clinic of the University of Guelph. The testing procedure takes about three weeks. On September 22, 2000 the tests results came back positive for the presence of nematodes.

Unfortunately, the University of Guelph only tests to the genus level and the California rating system rates nematodes by species, so the test results were not useful in terms of identifying whether the SSPP plants had economically important nematodes which would trigger a quarantine order in California. The samples were sent for further analysis to Dr. John Potter, a nematologist with Agriculture and AgriFood Canada who, in consultation

with Dr. John Chitumbar of the CDFA, identified the nematodes at the species level. Only one nematode species, Pratylenchus penetrans, was found in any significant numbers. This nematode is rated by the CDFA as a "C" nematode, "an organism subject to no state enforced action outside of nurseries except to retard spread – at the discretion of the county agricultural commissioner" (CDFA 1993).

Based on this information, and after consultation with CDFA and Ventura and Orange County officials and with SSPP's customers, it was decided to go ahead with the harvest. The California county officials were not concerned with the presence of Pratylenchus penetrans but, again, reserved their right to make their final decision after inspection. The customers, though concerned that Saskatchewan plants had nematodes at all, were willing to accept plants if the county officials approved them.

This episode had very important ramifications for SSPP in 2000 and also has implications for any future strawberry plant production in Saskatchewan, including:

- The discovery of nematodes delayed SSPP's harvest by one week while waiting for further identification of the species of nematodes present. This may have been avoided by sampling the field earlier, but it was recommended that sampling take place as close to harvest as possible and there was no expectation that nematodes would be found. This harvest delay forced SSPP to cut back the numbers of plants harvested. There was not enough time to fill the maximum order within the planting window in California even though the plants were available. In addition, a larger percentage of the plants were frost damaged than would have been the case if harvest had begun earlier.

- The presence of nematodes, and in quite large numbers, creates uncertainty regarding Saskatchewan's claim to have a clean environment for production. The California customers were disappointed to find out that there were nematodes in this new source of plants. The fact that California state and county officials are aware that nematodes may be present in Saskatchewan plants may increase the possibility of quarantine

orders being placed in the future. Saskatchewan may have to follow the California protocol for fumigation in order to reduce the risk of quarantine.

- If fumigation is not adopted, personnel and testing facilities for nematodes with the capability of testing to California standards will need to be easily accessible. The Pest Diagnostic Laboratory at the University of Guelph does not identify nematodes at the species level, which is needed to meet California standards. Dr. Potter at Agriculture and AgriFood Canada is not usually involved in testing on a commercial basis. A new ADF research project under the direction of Dr. Tanino is designed to develop the knowledge base among SAF personnel so that nematode testing can be carried out in the province.

- It is possible that the nematodes present in 2000 came with the registered stock purchased in California. In future years, this plant material will have to be tested for the presence of nematodes before being planted. It is unclear what the next step would be if nematodes were found, but the matter would likely have to be taken up at the intergovernmental level if no solution could be found between the purchaser and vendor of the plants. The government of California, as is standard, disclaims any responsibility for any problems with certified plants on the certification tags issued to growers. However, the presence of nematodes in its certified stock could possibly give Saskatchewan some leverage in negotiations over various regulatory issues. The presence of nematodes in California plant material is possible given the requirement in the California regulations for only commercial cleanliness in nursery stock and the granting of nematode-free certification based on the use of approved fumigation without annual laboratory testing.

Section 6. Business Arrangements

Section 5 of *Study 2* outlined the advantages and disadvantages of various business arrangements and strategies that might be employed in the development of a strawberry plant production industry in Saskatchewan that markets plants in California. Included in the discussion were independent Canadian companies, cooperative type arrangements (strategic alliances and contracts), and American-owned operations in Canada. This section presents additional research information on business arrangements as well as the experience gained from the SSPP commercialization activities.

6.1. Independent Saskatchewan Production

Strawberry plant production enterprises in Saskatchewan could develop similar to most existing Saskatchewan farming operations as independent, locally owned operations which are often sole proprietorships or family partnerships. There are benefits to this type of business organization. Independent local operators have the flexibility to operate and adjust their enterprises without outside interference and any profits realized belong to the local owners. In eastern Canada, strawberry plant operations tend to be family-run companies that, for the most part, produce independently and develop their own customer bases in Florida and elsewhere. These operations often produce other nursery or fruit crops, spreading their investment in machinery, buildings and labour over several complementary enterprises. California strawberry plant nurseries also appear to operate independently, often as family-run businesses, in a competitive environment.

In the case of Saskatchewan, there are some potential disadvantages to operating as independent sole proprietorships or family partnerships that might make some other types of business organization more desirable.

6.1.1. Managerial Expertise

There is wide variety of managerial expertise required to carry out the production and marketing of strawberry plants. It is rare for one individual or the members of one family to possess all these skills, especially in an area such as Saskatchewan where this type of production is not common. There is also the problem of time conflict. For example, there could be such a problem at harvest. If there is only one manager, he/she cannot be both in California monitoring plant arrival and be in the field in Saskatchewan harvesting plants. The ability to hire managers with the required expertise is probably limited in the Saskatchewan setting. The managerial problem could be mitigated by the involvement of several partners, where each has different, complementary skills. In SSPP's case there were five unrelated partners, each having different skills including knowledge of strawberry plant production, practical farming and mechanical experience, and accounting and marketing expertise.

6.1.2. Cooperatives and Cooperation

Because individual Saskatchewan plant producers would likely operate at quite small scales, at least initially, there are returns to size and scale that might be captured through cooperative business arrangements between a number of Saskatchewan growers. Various types of cooperation could occur among independent Saskatchewan operations without reducing their ability to independently develop production systems or market plants. There would also be the possibility of developing more formal cooperative relationships between Saskatchewan growers that would reduce the independence of individual growers in favour of cooperative business strategies.

6.1.2.a. Cooperative Machinery and Building Investment

Planters, harvesters, processing buildings and coolers are large capital investments that might be financed more easily and used more efficiently if shared between several producers. Cooperative processing at central locations where access to sufficient labour and other inputs is available may make it possible to produce plants in isolated areas of the province. It is known that the large California nurseries truck high elevation plants to

centralized processing facilities several hours away from the fields (these centralized facilities are still specific to individual companies, i.e. not cooperative). At processing rates similar to those observed in eastern Canada (3000 plants per day), it would take over 300 person days of trimming to fill a truck with one million plants. The labour employed by SSPP in 2000 was much slower than this (methods of improving the productivity of labour are presented in Section 3.3.2.d.). Even with improvements in labour productivity, there are only a few places in Saskatchewan that the amount of labour required to fill a truck in a short time period can be assembled without great difficulty.

6.1.2.b. Cooperative Transportation

Cooperative transportation of the finished product also would have advantages. In 2000, SSPP was forced to dispatch a partial load of plants to California. Even if harvest and processing had proceeded smoothly in 2000, two partial loads would have been sent because waiting for all of the plants to be processed would have delayed the first harvested plants long past the point when the customers would have wished them. Growers in Nova Scotia, although they process independently and compete for customers with each other, cooperatively transport seedstock from California in the spring and processed plants to Florida in the fall in order to send full loads on a timely basis.

6.1.2.c. Cooperative Information Gathering

Independent producers in Saskatchewan may find it difficult and expensive to gather production, regulatory and market information on such issues as fumigation, inspection, acreage and yields, crop progress, chilling levels, grower attitudes, and changes in business arrangements. They will need to keep abreast of developments in the both the strawberry nursery and fruit industries that impact on their businesses. Producers will have to develop their own networks of information. Some of this information is available on the internet or can be obtained from publications and telephone conversations. However, the best information is often obtained directly on site.

Even though California nurseries appear to be very competitive, there is important sharing of information through public institutions on aspects of plant production that are of common interest. For example, University of California - Davis, the university that has developed most of the strawberry varieties that are publicly available, holds a late summer field day especially for nurseries at the Irvine Station in Orange County. If representatives of each Saskatchewan nursery were to attend annually this would add the costs and time of an additional trip to California. Saskatchewan nurseries could cooperatively send a representative(s) on such fact-finding missions.

Saskatchewan producers could act cooperatively to monitor US and California regulatory systems and even to lobby regulators for changes or exemptions that would favour Saskatchewan production. As well, there will be a need to develop suitable regulations in Saskatchewan with grower and government cooperation.

6.1.2.d. Cooperative Client Service

California growers expect that when a problem emerges with a nursery's plants, the nursery will respond at a personal level. This may necessitate a visit to the grower to discuss the problem. Saskatchewan nurseries may have to use agents in California to carry out this service. Sharing an agent between several nurseries may reduce the costs and increase the quality of the response to customers and the information gathered on behalf of the Saskatchewan industry. The Saskatchewan industry may be able to develop a response to some issues more usefully as a group rather than as individual growers.

6.1.2.e. Cooperative Marketing

Study 2 made the statement that " . . . it could be very expensive for a small grower producing a million, or even several million, plants to directly market in California, although eastern Canadian growers do so in Florida." The experience gained by SSPP suggests that the costs of marketing are not necessarily prohibitive for a small Saskatchewan producer. In 2000, a five-day trip to meet with growers in Orange County and Oxnard cost approximately C $2,500 including airfare, car rental, hotel (4 nights), food and incidentals. With two trips required each year – one to line up orders and one to

accompany the plants - the cost per plant for a business selling one million plants would be about one half cent per plant. If a plant sells for C $0.13 (the price received by SSPP in 2000), this represents 3.8 per cent of the price of the plant. There are some other costs of marketing including telephone calls and, perhaps, promotional material that may raise this cost slightly and, if additional trips are required to California, the costs per plant would rise significantly.

Of course, the costs of marketing per plant should be lower for a larger producer or a cooperative since much of the marketing cost is fixed in the airfare. Even if longer visits are necessary for larger producers, the additional days will not add much to the total. There might also be other returns to individual Saskatchewan growers from marketing Saskatchewan plants advertised to have specific attributes of northern vigour through a single selling agency. Marketing might occur as a cooperative undertaking, or a business entity might be formed in Saskatchewan to purchase plants from producers direct from the field or after processing. These types of business arrangement would be a departure from what has been observed about business arrangements in the strawberry plant nursery business in North America where growers typically market much of their own production (there are some licensed distributors of University of California patented varieties who are not growers). One demand of such systems would be that growers would have to adhere to a strict set of production and processing requirements to ensure plant quality.

6.2. Business Alliances with American Interests

Other possible business arrangements include joint arrangements between Saskatchewan nurseries and American nurseries or fruit growers. As outlined in *Study 2,* the Canadian operations would concentrate on production and the American businesses would handle the marketing and deal with any problems with plants. Such strategic alliances could solve several threats to the success of Saskatchewan nurseries, but would introduce complexities in term of decision-making and sharing risk and profit.

At its simplest, a Saskatchewan/American strategic alliance could take the form of commitments from influential California fruit growers to support the development of a Saskatchewan industry through purchases and support on regulatory issues. The agreement by SSPP's customers in 2000 to "invest" in a Saskatchewan industry by ordering plants at premium prices before commercial production actually occurred and their continuing interest in Saskatchewan plants can be viewed as the foundation of such a strategic alliance. In the future, endorsement or, at least, recognition of the quality of Saskatchewan plants by a major fruit growers cooperative such as Naturipe Berry Growers, which has plans to expand its southern California acreage, should be a sought after alliance.

There is a case to be made for seeking alliances with California nurseries. Unless a more comprehensive production system can be developed in Saskatchewan that produces not only certified plants but also registered and foundation plants, independent Saskatchewan growers will be dependent on competing nurseries in California to annually supply them with seedstock. With such a system there is potential for importation of pests and disease or for supply disruption. In addition, new varieties released by the University of California are not available to plant producers outside the state for two years after being released to California nurseries. Given the rapid adoption of 'Camarosa' in the 1990's, lack of access to a new variety could be crippling to a Saskatchewan industry.

Some eastern Canadian strawberry plant growers have entered into contracts for a portion of their production with American nurseries. For example, some are producing specific varieties for Driscoll Strawberry Associates, a California company that has patented varieties. Others growers say that the terms of a Driscoll's contract are too onerous to accept.

Having a California nursery partner could potentially overcome the labour problem encountered by SSPP in 2000 where SSPP had great difficulty assembling labour for trimming. Saskatchewan may not have a dependable and affordable pool of labour to carry out this work. One of SSPP's customers made the novel suggestion that plants

harvested in Saskatchewan be trucked to California and trimmed there since there are contractors there that specialize in trimming plants for nurseries. This idea needs to followed up in terms of the logistics and costs of doing this. Potential problems include rejection of soil contaminated plants at the border and prohibitive transportation costs.

At the present time, it is likely safe to say that both California fruit and nursery interests are inclined to watch the Saskatchewan research with interest but without wanting to get involved very deeply. NorCal, one of the largest of the nurseries, has cooperated in some of the Saskatchewan research in the past but does not seem to be inclined to pursue the idea of a commercial interest in Saskatchewan production at this time. Some fruit growers and others in the California industry indicate that they have watched attempts at plant production in various places outside of the state fail and they do not hold out great hope for successful production in Saskatchewan. Saskatchewan will have to produce more consistent and superior results to trigger any interest in strategic alliances.

Section 7. Other Research

This section considers several research objectives that were not addressed in the preceding description and analysis of the business and market development initiatives of the researchers or the production and marketing activities of SSPP. Addressing these research objectives further develops the analysis of the economic feasibility of commercial strawberry crown production in Saskatchewan by beginning the economic and business assessment of:

- A potential industry development strategy of entering into the entire production process for strawberry crowns from nuclear stock through to certified plants in Saskatchewan, rather than using parent material from elsewhere to produce certified plants. This could include both southern varieties for sale into the United States and northern varieties for sale in western Canada and, perhaps further afield; and,

- The potential for improving marketable crown yields through the use of mulches and field cover regimes, hormonal applications, longer production cycles and various fertility regimes.

7.1. Development of a "Closed" Saskatchewan Certification Program

This section explores the rationale and potential strategies for developing a "closed" Saskatchewan certification system that would produce essentially pathogen-free and pest-free strawberry nursery plants in Saskatchewan for sale both throughout North America and beyond. "Closed" certification system refers to a system where a Saskatchewan agency would control and certify plant production in the province at each of the various levels of a certification hierarchy from nuclear stock to the certified level to ensure the

quality of the Saskatchewan product and protect the Saskatchewan production environment.

The North American Plant Protection Organization defines a certification program as "a domestic program consisting of the maintenance, multiplication, distribution and production of plant materials intended for release. . . . under an officially sponsored certificate attesting to the status of the material." Certification programs are based on the following principles: the sourcing of nuclear stock that is free from viruses and other pathogens, the prevention of reinfection during subsequent propagation steps and the maintenance of trueness-to-type (Spiegel 1998).

The goal of certification programs is to ensure that all material generated under the program meets the standards set by that particular program. Certification schemes are usually organized by government as government control is generally needed to ensure that regulatory measures are met and to provide the basis for granting phytosanitary documentation. However, some government programs may be funded or partially funded by grower organizations or private companies.

There are a number of strawberry plant certification programs in North America, each with its own particular regulations and procedures as laid down by each state or province. The authors have obtained the regulations that pertain to the certification of strawberry plants for the State of California and the provinces of Nova Scotia, New Brunswick, Quebec, Prince Edward Island and Ontario.[20] A closed certification system exists in California and for northern varieties in at least some of the Canadian provinces. In order to receive certification, the plant material must be descended from indexed nuclear stock via regulated multiplication methods. In California, propagation material from outside the state must be extensively tested before being accepted into the program. In Canadian provinces that multiply southern varieties for export to the United States, the certification of these southern plants is a more open system since the parent material (usually

[20] Elements of some of the systems are presented throughout this section. More information can be accessed by contacting the authors of this report.

registered stock) enters from an outside source (usually California) without testing. There is no direct control over the quality of the plant material coming from the outside sources. The efficacy of the certification system in the jurisdiction where the parent material originates must be depended on.

SSPP in 2000 purchased registered 'Camarosa' plants from licensed nurseries in California for mother plant material and sold first year daughter plants back to California fruit producers. These daughter plants, although meeting California requirements for certified plants as first year offspring of registered plants, could not be labeled "certified" because Saskatchewan has no official certification system for strawberry plants. An *ad hoc* nursery and processing plant inspection regime was developed based on what was known about the California system. The provincial fruit development specialist issued nursery stock inspection certificates detailing the field and processing plant inspection schedule and results for 2000 and referring to the plants as "certified level" plants and "propagated from California registered stock (Appendix B). This certificate and close consultation with California inspectors and customers satisfied their concerns about the quality of the plants, but still left the plant shipment vulnerable to being quarantined at California county borders.

Such a simple system of producing and selling plants into California could possibly work for some time, especially if Saskatchewan plants are considered to be superior to the best California nursery plants, thereby creating a specialized demand. As long as the Saskatchewan plants are consistently free of pathogens and pests, the *ad hoc* inspection system used in 2000 might be adequate. However, it would be in Saskatchewan's interest to develop a codified certification regime for southern varieties multiplied in Saskatchewan for one year that received official and ongoing approval from California, in order to avoid the uncertainty about county inspections experienced in 2000. This type of certification system seems to work for the eastern Canadian provinces that export to Florida.

In the case of exports to California there are problems which would not be addressed by this type of limited certification system since California is both the major source of propagation material and the major end market for nursery plants. First is the problem of sourcing mother plants from California nurseries that are competitors in supplying plants to California fruit growers. As long as a Saskatchewan industry remained small it would not likely offer much threat to California nurseries. The competitive nature of the nursery industry in California means that some nursery would likely supply enough plants to satisfy a small Saskatchewan demand. However, at some point California nurseries as a group might prove unwilling to supply mother plants to a competing nursery industry in Saskatchewan.

Second is the problem of plant quality. It will be imperative that Saskatchewan growers maintain a reputation for supplying vigorous, pathogen and pest free plant material. California nurseries might continue to supply mother plants to a large Saskatchewan industry but the quality of the plants might be low. California is home to a wide variety of diseases and pests that could be brought into Saskatchewan through planting material. Some Saskatchewan fruit producers who purchase certified nursery plants from California say that they have received diseased plants. Sources in Florida suggest that California nurseries did not supply them with high quality plants in the past, which was one reason they turned to eastern Canadian suppliers (confidential communication).

Third is the problem of meeting market demand for new varieties. University of California (UC) patented cultivars, currently 'Camarosa', dominate the southern California market. New UC cultivars are first released to California nurseries for two years before outside nurseries can obtain them. Given the example of the rapid adoption of 'Camarosa' in the late 1990's in southern California, a Saskatchewan nursery industry that relies on sales to California will be vulnerable to loss of market share during a transition period to a new variety. A closed certification system that relies on original nuclear stock of California cultivars would not resolve this issue, but the existence of a regulated certification program with the infrastructure and expertise it would require

might support the development of new Saskatchewan cultivars that would find favour in California and elsewhere.

7.1.1. General Characteristics of a Virus Certification Scheme

Spiegel (1998) provides an outline for a typical strawberry certification scheme involving several consecutive stages of propagation.[21] His scheme is outlined in Figure 7.1. The following is taken directly from Spiegel.

> Stage 1: Nuclear stock is composed of a limited number of healthy clonal plants, derived from selected pre-nuclear clonal plants after a therapy step if necessary, tested extensively for viruses-preferably for two growing seasons, and evaluated for trueness-to-type. Nuclear stock plants are grown in individual pots on raised benches, in screened enclosures under strict phytosanitary conditions, minimizing the risks of reinfection by vectors (*sic* viruses). Indexing is repeated several times throughout the year (zero tolerance). From nuclear stock, plant material is taken for growing "foundation stock."
>
> Stage 2: Foundation stock is derived directly from nuclear stock plants. Runners, severed from nuclear plants, are potted and maintained under conditions minimizing reinfection as above. Plants are indexed on a clonal basis rather than each individual plant. This stage of propagation may be done in isolated field plots.

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[21] Terminology - In order to understand the discussion on certification hierarchies it is necessary to provide definitions of some of the key terms. These terms are largely based on the California Department of Food and Agriculture Regulations for California Certified Strawberry Plants.

Index - to test for virus infection, usually by grafting test material onto indicator plants that will exhibit any virus infection present in the test material.

Heat treat – to place plants in a growth chamber at temperatures around 40 degrees C for several weeks. Viruses cannot keep pace with the growing tip and the clean tip is taken to produce new nuclear stock (Jamieson).

Nuclear stock - strawberry plants that were originally indexed and their progeny, which have been regularly reindexed and protected continuously from virus infection by an approved agency.

Foundation stock - strawberry plants that are first year propagation from plants that have been approved on the basis of annual indexing.

Registered stock - strawberry plants that are first year propagation from foundation plants.

Certified stock - strawberry plants that are first year propagation from registered stock.

Foundation block - a planting of strawberry plants for the production of foundation stock.

Increase block - a planting of strawberry plants for he production of registered stock

Certification block- a planting of strawberry plants for the production of certified stock.

Canadian certification schemes tend to include an extra level called E*lite stock* that refers to daughter plants grown from nuclear stock. In Canada, *Foundation* stock is obtained from *Elite* stock.

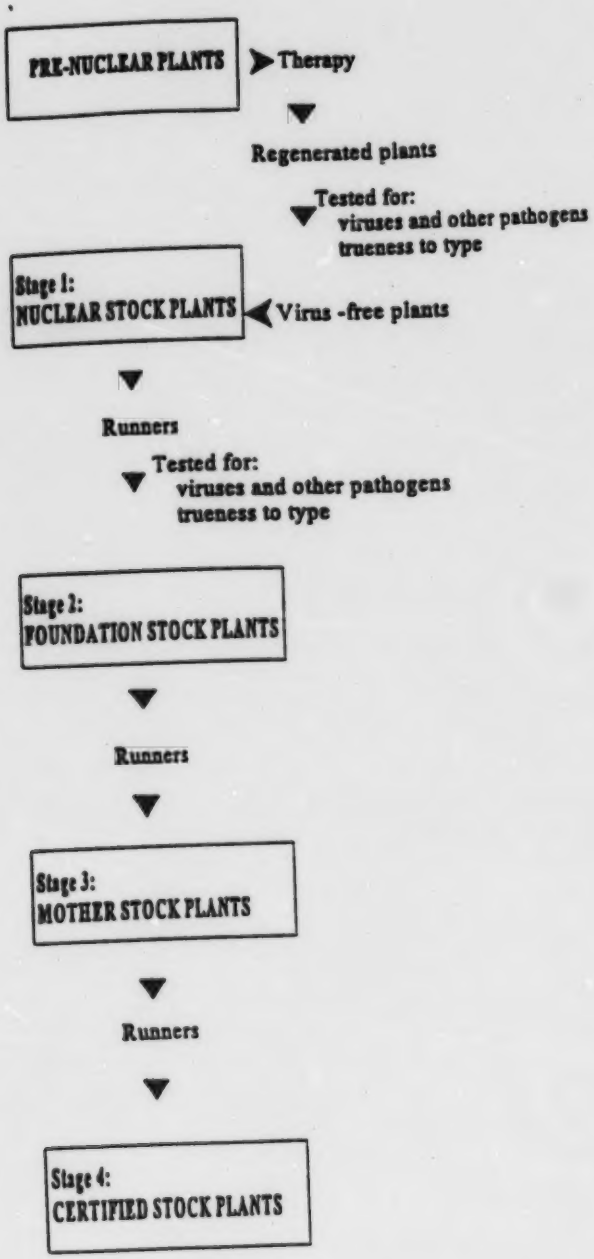

Figure 7.1. Stages of Production of Certified Strawberry Planting
Source: Spiegel 1998.
*Testing for viruses is done by leaf graft bioassays, enzyme-linked immunosorbent assays (ELISA), or by other appropriate methods. Plants are observed for symptoms of possible other pathogens (eg. fungi, bacteria). Testing of nuclear stock plants is done on individual plants, of foundation stock on each clone and of certified stock at random.

Stage 3: Mother (increase) stock is derived directly through runners from foundation stock as described in stage 2. This propagation step is usually done in the open field, located at least one mile from any other strawberry field and/or nursery. Plants are randomly checked for quality standards and diseases for which maximum tolerance levels have been defined.

Stage 4: Certification stock is derived directly from mother stock. Runners severed from mother stock plants are grown in nurseries for the final mass production of certified planting material. Plants are checked visually and if the required standards are met, plants are harvested and sold as certified stock which will be grown in commercial fruiting fields. It is recommended but not mandatory to grow certified stock under minimum reinfection conditions (Spiegel 1998).

One of the key differences between various certification schemes is the time limit to maintain nuclear stock. According to Spiegel this can range from one to four years. One other variation is the number of propagation stages between nuclear plants to certified stock. Another difference is that schemes can involve one or many crops.

7.1.2. Ontario Berry Propagation and Certification Program

Pam Fischer, Berry Specialist with the Ontario Ministry of Food and Rural Affairs (OMAFRA) has written a short synopsis of the propagation and certification program that exists for northern strawberry varieties in Ontario.[22] The main elements of this program are outlined in Figure 7.2. Fischer has described the process in terms of four steps.

Step 1. The screenhouse: Virus-tested plants, known as nuclear stock, are propagated in the screenhouse at Vineland, Ontario. This screenhouse:

- is designed to keep aphids and other insects from spreading virus to parent plant material;
- is owned by the University of Guelph and managed by the Ontario Berry Growers Association (OBGA);
- receives parent plants from Canadian Clonal Genebank at Harrow, or the tissue Culture Lab in New Liskeard (SPUD Unit).

[22] Details of Ontario's propagation program are presented in *Guidelines, Ontario Strawberry Plant Propagation Program* (Dale 1998).

Step 2: Elite Propagation Fields: Ontario plant propagators purchase Elite plants from the screenhouse. These plants are set out in propagation fields and grown according to the guidelines of the Ontario Plant Propagation Program. They are inspected for pest problems and variety mixes. The guidelines require:

- isolation in time (2 years) and space (1500 feet) from other plantings of strawberries
- planting in well drained, fumigated soil with no history of red stele
- weeds controlled
- varieties separated to prevent mixes

Step 3: Foundation Propagation Fields: Plants from Elite fields dug and re-planted for a second growing season, where they are known as Foundation plants. They are grown and inspected as per the guidelines.

Step 4: Plants sold to growers are fall or spring dug from foundation fields. The plant propagator may choose to include tags for plants that were grown according to guidelines of the program. The program is designed to provide healthy plants, true to name, to Ontario growers. Establishing a healthy field also depends on good management practices on behalf of the grower (Pam Fischer, unpublished).

Pam Fischer explains further that Agriculture and Agri-Food Canada (AAFC) maintains the nuclear stock plants in the Canadian Clonal Genebank and also does the virus testing. At the time of writing this report there are indications that AAFC will not continue to do the virus testing. As this is a very critical component of a certification scheme some other agency will have to take on this role. The Ontario Berry Growers Association (OBGA) administers the plant propagation program. It hires the field inspector who manages the screenhouse and inspects the fields. Dr. Adam Dale of the University of Guleph wrote the guidelines and provides technical advice. The University of Guelph maintains in-vitro culture of nuclear plants at the New Liskeard SPUD Unit. OMAFRA approves the guidelines for inspection and also appoints the inspector.

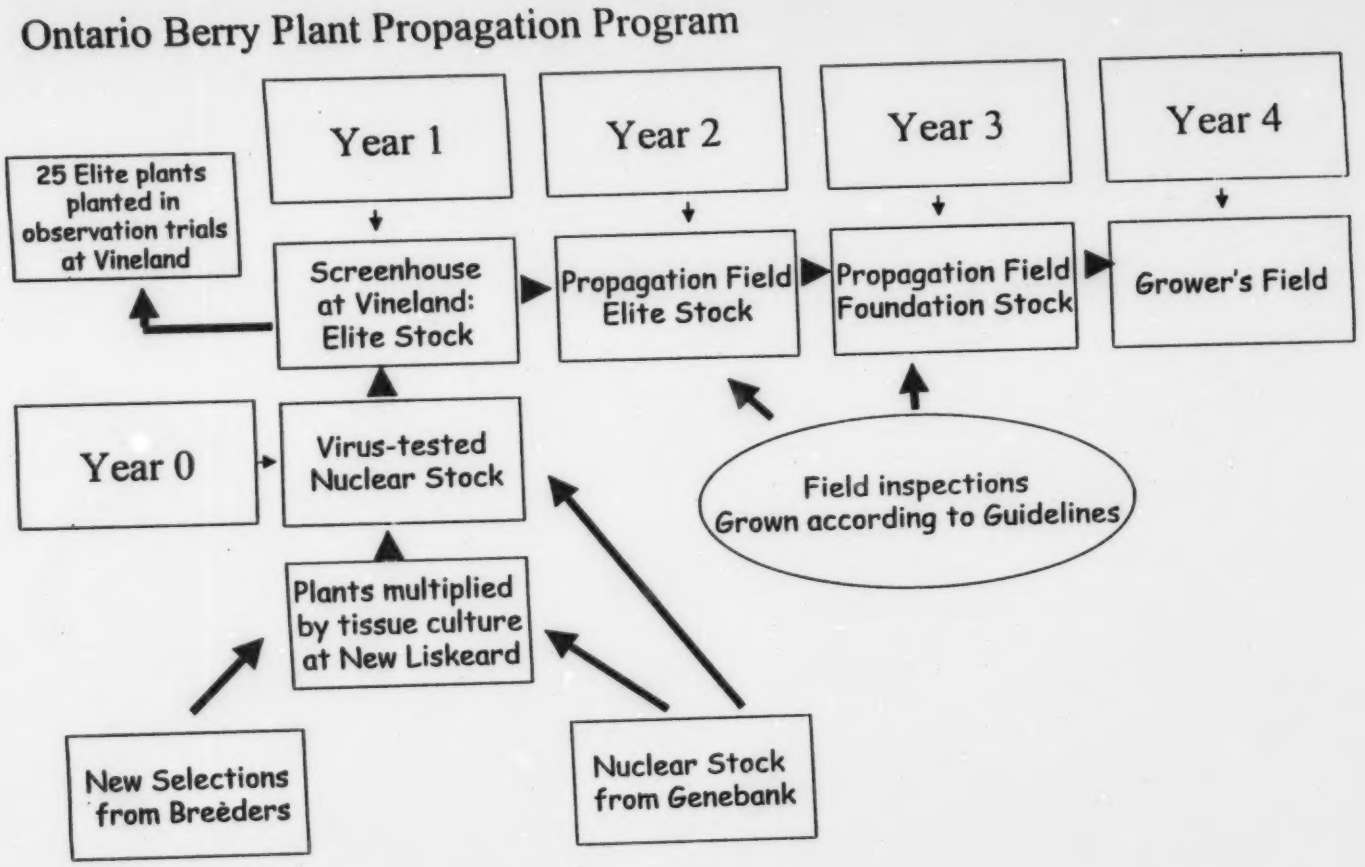
Ontario Berry Plant Propagation Program
Year 1
Year 2
Year 3
Year 4
25 Elite plants planted in observation trials at Vineland
Screenhouse at Vineland: Elite Stock
Propagation Field Elite Stock
Propagation Field Foundation Stock
Grower's Field
Year 0
Virus-tested Nuclear Stock
Field inspections Grown according to Guidelines
Plants multiplied by tissue culture at New Liskeard
New Selections from Breeders
Nuclear Stock from Genebank

Figure 7.2. Schematic of Ontario Plant Propagation Program
Source: Fischer, OMAFRA, 2001.

7.1.3. Nova Scotia Strawberry Plant Certification Program

AAFC has a screenhouse at Kentville where it maintains nuclear stock of a number of its varieties. This nuclear stock is sold to plant producers in the Maritimes (essentially Nova Scotia producers now) for further multiplication at C $10 per plant. AAFC generally maintains three or four plants of each variety in the screenhouse. Several offspring of each plant are virus-indexed over the winter. If there is no indication of viruses in these plants, the rest of the daughter plants are sold to plant propagators. If viruses are detected, the plant material is heat-treated to produce clean new nuclear stock (Jamieson, personal communication, 2001).

Nova Scotia has had an intensive inspection system as part of its certification program in which both federal and provincial specialists take part. However, this system is in a state of uncertainty at the present time as the province has reassigned some workers and is considering charging user fees that may make the present inspection system unaffordable.

There are two private plant propagators in the province who have screenhouses. One of these, Charlie Keddy, holds the licenses for several new varieties that originated at AAFC – 'Mira', 'Sable', 'Cabot' and 'Brunswick'. He supplies the Maritimes with these plants and is allowed to charge a license fee. He also receives a license fee from sub-licensees who multiply the varieties elsewhere in Canada.

7.1.4. New Brunswick Strawberry Plant Certification Program

New Brunswick produced certified strawberry plants (Canadian varieties) for many years at a government-operated centre. However, this centre closed after selling the 2000 production, owing to government cutbacks. Nuclear stock was obtained each year from AAFC at Kentville, Nova Scotia. This stock was multiplied for one season in a greenhouse and then multiplied via tissue culturing over one winter in a provincial laboratory (Coleman, personal communication, 2001). No virus testing took place since the process was considered to be a closed system. The resulting meristem plants were placed in a one-acre foundation (actually elite) planting the next spring and one year later

registered plants were planted on ten acres to produce certified plants. New Brunswick only produced certified plants of northern varieties for sale within the province.

7.1.5. Quebec Strawberry Plant Certification Program

The Quebec government maintains virus indexed mother plants of northern varieties that were originally obtained from AAFC. All further *in vitro* production of subsequent generations has been transferred to the private sector. Growers of southern varieties operate apart from the government certification and inspection program (Rousseau, personal communication, 2001).

7.1.6. Certification Program for Saskatchewan Production of Southern Varieties

It is not clear at present what is the best approach for developing a certification scheme for a Saskatchewan strawberry plant industry largely designed to serve the California and possibly the Florida markets. Even though there are valid concerns regarding dependency on California nurseries, it is likely that at the initial stages of a Saskatchewan industry, Saskatchewan nurseries will have to rely on them for mother plants. If Saskatchewan growers find that they cannot rely on California nurseries for suitable parent material, they may look at setting up a complete certification program where they maintain their own virus indexed parent material. This program could be developed independently or in conjunction with a public agency. It is possible that some private nursery in Saskatchewan would begin to produce the higher levels of plants in the certification hierarchy. This occurs for northern varieties in Ontario and Nova Scotia. However, it is critical that a public agency be involved in order to provide third party regulation. As outlined above for Ontario, the federal and provincial governments as well as the University of Guelph provide this third party legitimizing role.

A public agency such as the University of Saskatchewan, the federal government or the provincial government could also take the lead in establishing a certification program. Even though there has been a move toward privatization in some provinces, government

and universities have played the leading role in the original establishment of provincial certification systems by providing financial, regulatory and technical support. Such public support would likely be necessary in Saskatchewan, not only because the initial industry probably will be small and unable to provide the necessary expertise and infrastructure to privately support a certification program, but because there will be a need for communication and cooperation between a regulatory agency in Saskatchewan and its counterparts in California which are public agencies. Agricultural regulatory agencies in California wield a great deal of power and a Saskatchewan agency will have to be able to command some power also in order to be taken seriously.

7.1.6.a. Source and Maintenance of Clean Parent Stock

Saskatchewan strawberry producers licensed to propagate University of California cultivars can obtain virus indexed foundation plant material of these cultivars from the University of California's Foundation Plant Materials Service (FPMS).[23] FPMS maintains four mother plants of each UC variety from which it produces foundation plants on order. Plants are available first to California growers, then to out of state purchasers and finally to out of country purchasers. Virus indexed, heat treated, meristem cultured foundation stock plants sell for US $75.00 each *in vitro* and US $100 each for plants established in soil (FPMS internet site).

This foundation material could be used as the basis for a Saskatchewan certification program where all of the succeeding generations of plants would be grown under a regime of strict testing and inspection comparable to the California certification system, which includes taking foundation plants through a process of:

- heat treatment and meristem multiplication programs (any number of tissue culture generations can be grown, but each meristem must be grown to a plant);
- screenhouse planting for one season where every plant is virus indexed by grafting the first or second daughter to indicator plants;

[23] Internet address http://fpms.ucdavis.edu

- outdoor foundation block planting for one season where one per cent of the plants are indexed;
- increase block planting for the production of registered plants; and,
- certification block planting (Ogden, personal communication, 2001).

In addition, the certification program would have to include nursery sanitation requirements such as the control of nematodes either through fumigation or testing, and the control of other pests and weeds using methods and at levels satisfactory to California regulators and customers.

If Saskatchewan developed its own varieties of strawberries, it would have to maintain a stock of virus free nuclear material at either a public or private laboratory and would have to have the ability to multiply the nuclear stock to commercial levels economically. AAFC seems to be moving away from maintenance of nuclear stock even of its own varieties, so there is little chance it would maintain other plant material. However, there are private companies that have the capability of maintaining nuclear stock. Phyto Diagnostics of North Saanich, B.C. is a laboratory that does virus testing and maintains stock. To date, they have not done virus testing for strawberries. They do testing on potatoes for seven specific viruses and charge a maintenance fee of $200 per year for maintaining nuclear stock. The cost for strawberries would depend on whether the laboratory had the in-house reagents (De Villiers, personal communication, 2001).

Prairie Plant Systems Inc. (PPS) is a Saskatoon based company that provides laboratory services and propagates plants on a contract basis. PPS can supply virus free strawberry plants from tissue culture. To quote, "nuclear generation strawberries derived under aseptic conditions from tissue culture within PPS's laboratory will allow for the introduction of virus free strawberries to the protected environment of their greenhouses. The high quality production techniques and agronomic practices of an initial greenhouse crop would allow the product to be delivered to the field producers in plug form, thus

reducing the mortality rates associated with the direct transfer of strawberries from a laboratory to the field" (Masich, personal communication, 2001).

PPS has estimated that the cost of a plug plant supplied to the field producer would be $1.29 per plant based on a minimum contract of 1000 plants. These plants would be considered to be at the foundation level.

7.1.6.b. Maintenance of a Clean Environment

Certification regulations require higher level strawberry plants to be grown at some distance from lower level plants of the same variety and from plants of other varieties to protect against the spread of pests and disease (eg. in Ontario elite plants must be grown at least 1500 feet from other strawberry plantings). However, there are many ways that disease or pests can spread over much larger areas. The practice of bringing plants from a variety of North American locations into Saskatchewan for use in strawberry fruit production has potentially negative implications for strawberry nursery plant production. Diseases and pests can come with these plants. One horticultural researcher has suggested that if Saskatchewan develops certification programs for both southern and northern varieties, Saskatchewan strawberry fruit producers should be required to use only plants from within that certification system to plant for fruit production to minimize the chances of introducing disease or pest problems.

7.1.6.c. Infrastructure and Personnel Requirements

A tissue culture laboratory, virus and pest testing facilities, greenhouse and screenhouse facilities, isolated multiplication plots and the necessary professional, technical and support personnel would be required to carry on a successful closed certification program. Some of these exist in the private sector such as the examples of Phyto Diagnostics and Prairie Plant Systems given above.

Field inspection can be very labour intensive, requiring large inputs of professional time. In Nova Scotia, three field inspections are carried out each growing season using as many

as seven specialists and technicians from the provincial and federal governments to inspect about eighty acres a day. This system, which has been government funded, is in a state of uncertainty at the present time as the provincial government is reorganizing the system and part of it may be privatized. It may be that there will be fewer inspections in a privatized system, if the growers have to bear the costs of inspection. Ontario, which has a privatized inspection system, requires fewer inspections. In New Brunswick, which was entirely a government operation, the provincial plant pathologist and provincial berry specialist carried out several in-field inspections annually.

7.1.6.d. Certification Program Costs

There does not appear to be any specific public information on the cost of developing a strawberry certification scheme. The initial costs may be significant, not only to provide the necessary infrastructure and engage the services of the required personnel, but to codify the regulations and ensure the congruity of the program requirements with those of other jurisdictions, especially California. Many of these costs will likely have to be initially assumed by government in order to support the development of an industry. It may be that there are existing facilities and personnel that can utilized to accomplish some of the on-going requirements of a certification program. For instance, existing Saskatchewan government personnel employed at the provincial agricultural laboratory are receiving training in nematode testing as part of the ongoing horticultural research into strawberry plant production. Grant Holzgang of the provincial laboratory will be going to California in early 2002 to be trained by Dr. John Chitumbar, a nematologist with the CDFA. Dr. Chitumbar will be visiting Saskatchewan in April 2002 to provide further training.

7.2. Production and Storage of Northern Varieties

A Saskatchewan certification program initially developed for the production of existing southern varieties could also begin to produce existing northern varieties or support the development and production of new Saskatchewan varieties, either southern or northern. There are a number of factors that do not make the production of northern variety plants as attractive as production of southern varieties:

- the demand for northern variety strawberry plants is much smaller than for southern variety plants. The acreage of strawberry fruit production in the northern United States and in Canada has been in decline for many years. In addition, northern fruit acres are not replanted each year and the planting density is lower than for southern varieties. The North American demand for northern varieties can be estimated at a maximum of one hundred million plants annually with the demand in Canada being less than one half of this amount. Since Saskatchewan production of northern plants would be unlikely to replace the well-established production operations in eastern Canada or in the United States, the potential market is much smaller. Strawberry fruit growers in Saskatchewan may require about one million plants annually.

- the prices paid for northern varieties are lower than the potential premium prices for southern varieties in the US market. SSPP received US $0.09 (C $0.135) per plant delivered to California in 2000. While this high price may not be sustainable, eastern Canadian producers do receive about US $0.07 to US $0.75 (C $0.105 – $0.115) per plant delivered to Florida. The price of northern varieties produced in eastern Canada is about C $0.075 per plant plus delivery charges (Strawberry Tyme Farms, 2001) .

- the production of northern varieties requires storage facilities to over-winter processed plants since customers usually do not take delivery of the plants until the spring. The initial costs of building long term storage facilities, the operating costs and the risk attached to carrying plants over winter are high.

Some of the large eastern Canadian plant producers claim that production of northern varieties is not very profitable relative to production of southern varieties (confidential personal communication, 2001). The province of Alberta looked into establishing a certified strawberry plant production industry for northern varieties about twenty years ago and concluded that there would need to be production of six to eight million plants per year at a minimum and that even then, the requirements for virus indexing, screen housing, inspection and storage were too expensive and complicated (Hausher, personal communication, 1998).

It appears from the above discussion that production of northern varieties would not be the major focus of a strawberry plant production industry in Saskatchewan. However, as permanent storage and cooling facilities and regulatory regimes are developed to meet the needs of an industry focused on production of southern plants, production of northern plants might be added as a complementary enterprise.

7.3. Research into Improving Daughter Plant Yields

Dr. Tanino's research team at the University of Saskatchewan is investigating the potential of improving daughter plant yields in a series of ongoing experiments in the areas of mulch application, fumigation, fertility, herbicide application, hormone application (benzylaminopurine or BAP), tissue culturing, and using a two-year production cycle.[24] There has been wide variability in many of the results from year to year that may be attributable to variability in the quality of planting materials, variability in the quality of soil within and between test plots and variability in weather factors. The 2001 results of the horticultural experiments "suggest that using a fertility regime of 200 lbs./ac of nitrogen, adding floating row covers of *Remay* to strawberry fields and propagating strawberry crowns in tissue culture are all positive methods to increase the number of daughter plants. Hormonal dips of BAP and the use of Treflan seem to be detrimental to daughter formation, while fumigation has no effect on the number of

[24] The most recent results of this research are found in Krieger and Tanino (December 2001).

daughters produced (Krieger and Tanino, December 2001)." More years of tests are required before the effects on productivity of these techniques are clearly identified and quantified. Contrary to the negative 2001 results of the BAP and Treflan treatments in 2001, tests in 2000 of BAP and Treflan were positive. Fumigation has only been tested for one year and the condition of the planting material used in that test was poor. The results of the experimental work on the benefits of a two-year production cycle are unclear because of problems with the experimental material and site.

Given the variability in research results and the short history of the university research and of commercial production in Saskatchewan, it is difficult at this time to determine the economic benefits these production techniques may have at a commercial scale. However, some of the potential economic ramifications of using these production techniques commercially are identified and analyzed in the following sections.

A number of tables are presented that estimate the increased revenues and costs of using the various production-enhancing techniques. Breakeven yield increases are calculated for many of the techniques, based on current research knowledge and production information from SSPP and other strawberry plant producers. The base yield used of 61,500 plants per acre is the number of marketable plants estimated to have been available in the SSPP field before harvest in 2000. The premium price received by SSPP from California producers in 2000 is used to calculate revenue while the extra processing cost incurred because of increased production is based on observations of processing in eastern Canada. It could be argued that this overstates revenue and understates costs. However, *Study 2* presented a strong economic case for Saskatchewan plants attracting a price premium in California and California fruit producers remain very interested in Saskatchewan plants despite the problems experienced by SSPP in 2000. In addition, the exchange rate used in the tables of 1.5 Canadian dollars to one US dollar is conservative. SSPP's processing costs in 2000 were about double the costs used in the following tables but previous sections of this report explain how these high costs can be reduced with more experience and better planning.

7.3.1. Mulches and Field Covers

There are a wide variety of mulches and field covers available that could be tested for their effect on daughter plants produced per mother plant including clear and coloured plastic mulches, perforated tunnel coverings and "spunbonded" polyester and polypropylene crop covers. The desired effect of using these coverings is the creation of a favourable microclimate around the plants (higher temperatures, more consistent moisture and protection from wind) to encourage increased runnering. Krieger and Tanino tested both black plastic mulch and *Remay*, a spunbonded crop cover, in 2000. They found:

> no statistical differences between the number of rooted crowns and total number of daughters per mother produced among the three treatments (no mulch, black plastic and Remay). However, the variation within the data was extremely high (CV 104%). Soil texture had varied markedly across the field ...Visual inspections in the field suggested that significant differences should have existed between treatments. Although not statistically significant, plants grown under the Remay produced a greater number of mean rooted and total number of daughter plants per mother. The black plastic mulch treatment applied in 2000 reduced the number of rooted daughter crowns compared to the Remay treatment. (Krieger and Tanino, December 2001).

In 2001, the university testing concentrated on Remay. 'Camarosa' crowns grown under Remay in 2001 produced a significantly greater number of total crowns than unprotected plants (50% more). Even more importantly, Remay-protected 'Camarosa' plants produced 70% more marketable daughter plants than did plants grown on bare ground, suggesting that not only were the conditions for runnering better under the field cover, but that the conditions for rooting daughter plants were also better. Other strawberry cultivars also performed better under Remay in the university experiments but the increase was not as dramatic as for 'Camarosa'. 'Sweet Charlie', a Florida cultivar, had an increase in marketable crowns of about 9% under Remay while the two northern cultivars tested, Totem and Kent, responded somewhat better. The 'Sweet Charlie'

planting material was in poor condition when it was planted and yield of both unprotected and protected plants was probably adversely affected.

The increase in yield observed when plants are multiplied under Remay must be balanced against the cost of using the technology. The material is expensive at C $0.035 per square foot or more or about C $1,500 per acre (WaterTec, personal communication, 2002). Application is labour intensive. Although the material can be purchased in varying widths from five feet wide and up, the large sheets of material up to sixty feet wide and one thousand feet long that would be suitable for covering large field areas can be difficult to handle, especially in windy conditions (Waterer, personal communication, 2001). A tractor and up to six people might be required to lay the material out and secure the edges. The material may have to be taken up and relaid several times a year to facilitate weeding since weeds also thrive in the microclimate created under the field cover.

Table 7.1 provides estimates of the potential economic costs and benefits of using field covers for commercial strawberry plant production. In Table 7.1, the yield of marketable daughter plants grown under row cover is increased by 70% and 9% over SSPP's estimated yield of marketable daughter plants grown on bare ground in 2000, based on the 2001 university trial results for the southern cultivars 'Camarosa' and 'Sweet Charlie'. Sale price is based on the US $0.09 (C $0.135) per plant received by SSPP in 2000. Installation labour includes placement and removal of the field cover three times using six workers. It is estimated that it takes one hour per acre to place or remove the cover and that the workers are paid $6.50 per hour. A tractor is assumed to be rented at $10 per hour for half of the time used to place and remove the field cover.

Extra processing costs (mostly labour) and shipping costs (packing material and trucking) are incurred to deal with the extra plants produced under field cover. The processing costs used in Table 7.1 reflect the labour costs of processing at work rates observed in eastern Canada. If the high labour costs of processing experienced by SSPP in 2000 are used, the extra returns from using field covers in this scenario are severely reduced. The

yield increase required to cover the extra costs of using field covers based on SSPP's 2000 processing labour costs would be over 50% versus the 29% calculated in Table 7.1.

Most other costs should not be affected by the higher yields achieved under field covers. Irrigation costs may decrease in a row cover system since moisture is retained better underneath the covers. The cost of hand setting runners should decrease because a higher percentage of runners will root unaided in the warm, moist, calm conditions under the covers. However, weeding costs may increase depending on the weed populations in a given field. As noted above, weeds also thrive under cover. Using clean fields for production, which is already very important to successful plant production, will become even more so. It would be very useful to have the ability to use a herbicide such as trifluralin in such a system, but the concerns of customers over any herbicide use will have to be allayed before such a practice is adopted.

Table 7.1. Estimated Costs/Benefits of Using Field Covers (C $).

	Bare Ground	*Field Cover (70% yield increase – 'Camarosa')*	*Field Cover (9% yield increase – 'Sweet Charlie')*
Mother Plants/Acre	10,000	10,000	10,000
Yield/Acre (marketable plants)	61,500	104,500	67,035
Sale Price/Plant (Exchange Rate 1.5 C$ to 1US$)	$0.135	$0.135	$0.135
Gross Revenue/Acre	$8,300	$14, 107	$9, 050
Extra Marketable Plants/Acre		43,000	5,535
Total Extra Gross Revenue/Acre		**$5,804**	**$748**
Extra Field Costs/Acre - material - installation labour - tractor rental		 $1,500 $240 $30	 $1,500 $240 $30
Extra Post-harvest Costs/Acre* - processing labour and management - packaging and shipping		 $1,300 $250	 $166 $32
Total Extra Costs/Acre		**$3,320**	**$1968**
Net Extra Revenue/Acre from Using Field Covers		**$2,484**	**($1220)**
Breakeven % Yield Increase (extra costs = extra revenue)		**29%**	

Source: Krieger and Tanino, December 2001; SSPP 2000; authors' calculations.
*Extra yield increases per acre processing and shipping costs. Processing costs of C$0.03 per plant are based on estimated eastern Canadian costs; packing and shipping costs of $0.006 per plant are based on the cost of shipping full trucks from Saskatchewan to California.

The costs of harvesting and trucking larger amounts of harvested material to the processing plant could increase, but the inefficiencies noted in SSPP's 2000 operation in this area leave room for improvements that should offset this. In fact, the higher total numbers of marketable daughter plants produced per mother and the higher percentage of total daughter plants produced that are marketable under a row cover system may increase the efficiency of both the harvest operation and the processing operation. Less waste material in the form of rejected plants may have to be handled.

The increase in marketable plants from using field covers must be quite large to be economical. In table 7.1, the breakeven percentage yield increase at the premium price SSPP received in 2000 and with more efficient labour rates than achieved by SSPP in 2000 is 29%. If price premiums cannot be maintained, if labour is less efficient or if the costs of using field covers rise, this yield advantage will have to be even higher. Increased efficiency in processing or weeding will reduce the increase in productivity required to make the system economical.

7.3.2. Fumigation

Soil fumigation prior to planting is carried out as a matter of course at strawberry plant nurseries across North America to control nematodes and other soil-borne diseases and pests. SSPP did not fumigate in 2000. Soil tests in the fall of 1999 at the various test sites for strawberry plant production in Saskatchewan showed no, or very low levels of, nematodes. Therefore, it was assumed that nematodes would not be a problem. However, the existence of fairly large numbers of nematodes in tests carried out prior to harvest 2000 suggests that it may be necessary to fumigate, at least some years, in Saskatchewan to control nematodes. Fumigation may be necessary to reduce the risk of having plant shipments rejected on the grounds of suspect disease or pest sanitation when selling into other jurisdictions. Other provinces where certified strawberry plants are produced for export require production in fumigated soil as a matter of course. Plants grown on fumigated soil will certainly be more readily accepted by California regulators

and customers. On the other hand, being able to successfully produce marketable plants without fumigation may provide Saskatchewan with an advantage if the use of soil fumigants is restricted or phased out, as is happening with methyl bromide, the principle fumigant used in California.

Fumigation is a high cost input. Costs per acre for the products at rates used in eastern Canada range from C $750 to C $1,200 per acre or more annually depending on the fumigant and rates used (AgroSpray, personal communication 2002). To fumigate in Saskatchewan there would be an additional cost of shipping the products by special courier from Ontario, since they are not typically available in the west. Fumigants also require the use of specialized application equipment. There are no custom applicators in western Canada so machinery would have to be purchased or developed. AgroSpray of Tllsonburg, Ontario custom builds machinery of various types and cost (see Study 2, pp. 56-57).

Despite the high costs of fumigation, the practice may be economically viable if it increases the marketability of a crop, offsets other expenses or provides increased revenues. It may be possible to reduce the cost of fumigation in Saskatchewan by using low rates or skipping application in some years in Saskatchewan if the disease and pest pressure is low.

Weed control from fumigation was listed as one of the biggest economic and management benefits of fumigating by some eastern Canadian producers interviewed by the authors. They suggested that fumigation eliminates the first weeding operation of the year, a major cost saving. In the case of SSPP in 2000, the cost of the first weeding was about $300 per acre. This cost was higher than what would be expected for a more experienced producer producing on cleaner land. Still, the savings from eliminating one weeding operation would be large. Based on eastern Canadian information gathered for *Study 2,* the cost of a first weeding would be at least $150 per acre without fumigation.

Fumigation is reported to have a positive effect on the yield of crowns. Research in Ontario suggests that plants grown in fumigated fields grow more vigorously than those grown in unfumigated fields (Lanthier, personal communication, 1999). Dale reported that the introduction of fumigation in strawberry plant production in Ontario doubled crown yields (personal communication, 1999). Research tests carried out in various locations in the United States have found that the use of soil fumigation improves strawberry crown productivity even where specific soil-borne disease or pests are not a major problem. Hancock et al. (2001) suggest that modern strawberry cultivars have little resistance to a wide variety of soil-borne pathogens and that fumigation eliminates "non-specific sub-lethal root pathogens or deleterious rhizosphere colonizers." They found that fumigation almost doubled production of runners in tests in Michigan even in the absence of major root and crown diseases. On the other hand, Waterer suggests that northern vigour in Saskatchewan-grown plants may be partly dependent on the activity of beneficial soil mycrorhiza and that fumigation would likely have a negative impact on the populations of these organisms. The seed potato industry on the Canadian prairies has not generally found that fumigation is beneficial, whereas it is considered beneficial in other seed potato producing areas of North America (personal communication 2002).

In tests at Outlook in 2001, Camarosa plants grown in soil fumigated with Basamid® (product of BASF Canada Inc.) did not produce significantly different numbers of marketable or total daughter plants than Camarosa plants grown in untreated soil. The poor quality of the mother plants and the iron deficiency experienced during the growing season may have affected the outcome of this test (Krieger and Tanino, 2001). It will be important to carry out further tests with both Basamid® and other fumigants before any useful conclusions can be drawn from the research.

Table 7.2 compares the cost of fumigation with the potential cost savings and increases in revenue that might occur if fumigation did eliminate one weeding operation and increase yields. The processing costs used in Table 7.2 reflect the labour costs of processing at work rates observed in eastern Canada. If the high labour costs of processing

experienced by SSPP in 2000 are used, the extra returns from using fumigation would be reduced in this scenario are reduced.

According to the Table 7.2, it would take about a 13% increase in yield to cover the extra costs of fumigating at the lowest fumigation cost. A 25% yield increase would cover the costs of fumigating at the highest cost. The costs of fumigating in Saskatchewan may possibly be lower than the lower cost used in Table 7.2 if rates can be reduced, if different combinations of fumigants can be used, or if fumigation is only used in years when nematodes or other pests or diseases are expected to exceed certain thresholds. The value of the lower risk that plants grown in fumigated soil have of being rejected by regulatory officials in other jurisdictions also will have to be factored into any decision on the economic value of fumigation.

Table 7.2. Estimated Costs/Benefits of Fumigation (C $)

	No fumigation	*Fumigation (13% yield increase)*	*Fumigation (25% yield increase)*
Mother Plants/Acre	10,000	10,000	10,000
Yield/Acre (marketable plants)	61,500	69,495	76,875
Sale Price/Plant (Exchange Rate 1.5 C$ to 1US$)	$0.135	$0.135	$0.135
Gross Revenue/Acre	$8,300	$9,382	$10,380
Extra Marketable Plants/Acre		7,995	15,375
Total Extra Gross Revenue/Acre		**$1,080**	**$2,078**
Change in Weeding Costs/Acre		($150)	($150)
Change in Post-harvest Costs/Acre* - processing labour and management - packaging and shipping		$240 $48	$460 $95
Total Extra Costs/Acre (excluding fumigation cost)		**$138**	**$405**
Net Extra Revenue/Acre from Fumigation (excl. fumigation costs)		**$942**	**$1,673**
Costs of fumigation/acre*		**$900 to $1,600**	

Source: SSPP 2000; *Study 2;* authors' calculations.

*Extra yield increases per acre processing and shipping costs. Processing costs of C$0.03 per plant are based on estimated eastern Canadian costs; packing and shipping costs of $0.006 per plant are based on the cost of shipping full trucks from Saskatchewan to California.

**Includes fumigant, fumigant shipment from eastern Canada and costs of application.

7.3.3. Hormonal Dip

The university research work to induce increased runnering through various levels and methods of hormone application to strawberry mother plants has had mixed results. The research in 2000 and 2001 concentrated on the method of briefly dipping mother plants prior to planting in a non-toxic solution of 6-benzylaminopurine or BAP (250mg/L of water).

The yield data from these two years is inconclusive. In 2000, the BAP treatment yielded 82% more rooted daughter plants than the control, but in 2001 the control yielded about 40% more marketable daughter plants than the BAP treatment (Krieger and Tanino 2001). Table 7.3 below estimates what the cost per acre would if the BAP treatment used in 2000 and 2001 was employed at a commercial level. The table indicates the breakeven increase in yield required (7%). The returns from a 25% yield increase are also shown for comparison.

Table 7.3. Estimated Costs/Benefits of Using 6-benzylaminopurine (BAP) Dip (C $).

	No BAP	*BAP Treatment (7 % yield increase)*	*BAP Treatment (25% yield increase)*
Mother Plants/Acre	10,000	10,000	10,000
Yield/Acre (marketable plants)	61,500	65, 805	76,875
Sale Price/Plant (Exchange Rate 1.5 C$ to 1US$)	$0.135	$0.135	$0.135
Gross Revenue/Acre	$8,300	$8,883	$10,380
Extra Marketable Plants/Acre		4,305	15,375
Total Extra Gross Revenue/Acre		**$580**	**$2,078**
Extra Field Costs/Acre - BAP (250mg/L) - dipping labour		 $350 $65	 $350 $65
Change in Post-harvest Costs/Acre* - processing labour and management - packaging and shipping		 $140 $25	 $460 $95
Total Extra Costs/Acre of BAP treatment		**$580**	**$970**
Net Extra Revenue/Acre) from BAP treatment		**$0**	**$1,108**

Source: Krieger and Tanino, December 2001, SSPP 2000; authors' calculations.
*Extra yield increases per acre processing and shipping costs. Processing costs of C$0.03 per plant are based on estimated eastern Canadian costs; packing and shipping costs of $0.006 per plant are based on the cost of shipping full trucks from Saskatchewan to California.

In Table 7.3 it is assumed that one litre of 250mg/L BAP solution will treat 100 plants (25 grams BAP in 100 litres of water will treat 10,000 plants or one acre of planting). A bulk price for plant cell culture tested BAP was received from Sigma-Aldrich Fine Chemicals, Oakville Ontario (about $350 per 25 grams or per acre). This price may be high since Sigma-Aldrich supplies chemicals primarily to research organizations, but BAP is not available otherwise in Canada except in combination with other growth regulators (Groen, personal communication 2001). The cost of the surfactant Tween 20 used in the BAP solution is negligible at less than $1.00 per acre.

It is assumed that the dipping process would require one extra labourer in the planting crew. At the speed of planting employed by SSPP in 2000 with a single-row planter, this is equivalent to an extra person-day in wages per acre or about $65 per acre. There would be little requirement for investment in extra equipment at smaller acreages since only 100 litres of solution would be used over the course of a day to plant an acre. Pails carried with the planter would likely suffice. Larger planters might require some modification to the planting equipment to carry the solution, but the labour requirement might fall, since one person might be able to handle the dipping for a two or four row machine also.

The BAP treatment outlined above has economic potential if it increases yields relatively modestly. In addition, it does not seem to be a technically difficult or particularly disruptive additional step in a planting system.

7.3.4. Tissue Culture

Krieger and Tanino (2001) tested the effects on subsequent daughter plant production of applying various rates of the hormone 6-benzylaminopurine (BAP) to tissue culture media. The various treatments did not produce significant differences in yield of daughters per mother in 2001, although unreplicated treatments in 2000 had suggested that 0.5 mg/L of BAP produced more daughter plants than the other BAP treatments that were evaluated (control, 0.25mg/L and 1.0mg/L).

In 2001, however, all of the tissue culture treatments including the control produced higher numbers of daughters per mother than the non-tissue cultured plants used in the various other studies of the research team. The tissue cultured plants produced between 27 and 30 total daughters per mother on average and 12 to 14 marketable daughters per mother on average, versus the 6 to 9 total daughters and lower number of marketable daughters per mother that have been common in tests of non-tissue culture plants or the 6.15 marketable daughters per mother estimated to have been in the field prior to SSPP's harvest.

According to Bish et al. (2001), the consistently higher production of daughters from micropropagated (tissue cultured) mothers relative to the daughter yield of daughters of micropropagated plants and daughters of standard propagated plants has been well-known for many years. Bish et al.(2001) conducted greenhouse experiments in 1995 and 1996 where micropropagated plants produced 27% to 40% more daughters than did daughters of micropropagated plants (depending on cultivar) and 76% to 89% more daughters than standard propagated plants. The study concluded that all of Florida's requirement for strawberry plants for fruit production each year (100 million plants) could be supplied as plug plants produced from tissue cultured mother plants in 10 acres of greenhouse space.

Despite the high productivity of tissue cultured plants, there is debate in the strawberry industry about their proper place in a propagation system. Tissue culturing is restricted in the California certification system to the higher levels of the system – foundation and higher. Plants that are originally tissue cultured must be multiplied for several generations in the field before they are certified to use for fruit production. Many strawberry fruit growers in California and elsewhere have been unimpressed with tests of tissue cultured plants on the basis of various characteristics such as vigour, growth habit and fruit quantity and size (personal conversations with various growers). Dr. Tanino at the University of Saskatchewan has carried out some tests on the vigour of offspring of tissue-culture plants by taking the field-grown daughters of tissue culture plants and

measuring their flower production in greenhouse conditions. The results of these tests are not yet available.

Tissue culture plants are also expensive. Prairie Plant Systems of Saskatoon estimates it could provide virus free plug plants from tissue culture for C $1.29 per plant (Masich 2001). Nourse Farms of Massachusetts sells virus-tested tissue culture plants for about US $0.85 per plant, about the same price as Prairie Plant System' estimate. Nourse Farms sells daughters of tissue cultured plants for about US $0.175 per plant or C $0.26 (Bish et al. 2001). In contrast, field-grown registered plants from the California certification system can be purchased for about C $0.08 per plant.

Table 7.4 estimates the benefits and costs of using tissue cultured plants and daughters of tissue cultured plants as registered level mother plants. If tissue cultured plants were used at the registered level to produce certified plants, yield advantages would have to be large for the practice to be economically viable. Even with a doubling of marketable plants such as Krieger and Tanino (2001) achieved with tissue culture mothers relative to the per mother production of SSPP in 2000, there would be a large per acre financial loss. The 200% increase over SSPP's 2000 yields which would be needed to breakeven using tissue culture mother plants might have been achieved in the 2001 tests if the rooting success of the daughter plants had been higher. There were, on average, about eight daughters of marketable size per mother that did not root in the tests. If six of those had rooted under more intense management, the 200% increase would have been achieved.

Daughters of tissue cultured plants produced 27% to 40% more daughters than non-tissue culture mothers according to Bish et al. (in greenhouse production). Table 7.4 estimates a yield increase of 36% would be required to cover the extra costs of using daughters of tissue culture plants as registered-level mother plants.

Producing certified plug plants from tissue culture mother plants may have potential in Saskatchewan. The production process would be more controlled than standard propagation in open fields and the product should be very clean in terms of disease and

pests. Prices of US $0.15 to US $0.175 per plug plant have been reported in California and Florida (almost double the price received by SSPP in 2000) and California producers are becoming more interested in the product.

Table 7.4. Estimated Costs/Benefits of Using Tissue Culture Mother Plants (C $).

	a. Field Propagated Mothers and Daughters	*b. Tissue Culture Mothers/Field Propagated Daughters (100% yield increase)*	*c. DTC Mothers*/ Field Propagated Daughters (40% yield increase)*
Mother Plants/Acre	10,000	10,000	10,000
Yield/Acre (marketable plants)	61,500	123,000	86,100
Sale Price/Daughter Plant (Exchange Rate 1.5 C$ to 1US$)	$0.135	$0.135	$0.135
Gross Revenue/Acre	$8,300	$16, 600	$11, 625
Extra Marketable Plants/Acre		61,500	24,600
Total Extra Gross Revenue/Acre		**$8,300**	**$3,320**
Extra Field Costs/Acre** - mother plants - extra planting labour (100% increase)		$12,100 $400	$1,800 $400
Change in Post-harvest Costs/Acre*** - processing labour and management - packaging and shipping		$1,845 $370	$740 $150
Total Extra Costs/Acre		**$14, 715**	**$3,090**
Net Extra Revenue/Acre)		**($6,415)**	**$230**
Breakeven % Yield Increase (extra costs = extra revenue)		**Approx. 200%**	**36%**

Source: Krieger and Tanino, December 2001; Bish et al. 2001; SSPP 2000; authors' calculations.

* "DTC Mothers" refers to mother plants that are the daughters of tissue culture plants.

** Extra cost of mother plants in column b) is C $1.21/plant = the cost of tissue culture plug plants ($1.29 based on Prairie Plant Systems estimate) minus the cost of field-grown registered plants (C $0.08). Extra cost of mother plants in column c) is C $0.18/plant = the cost of daughters of tissue cultured mothers (C $0.26 based on Bish et al. 2001) minus the cost of field-grown registered plants (C $0.08).

Planting labour costs are doubled to reflect the extra work involved in planting plug plants versus bare root plants.

*** Extra yield increases per acre processing and shipping costs. Processing costs of C$0.03 per plant are based on estimated eastern Canadian costs; packing and shipping costs of $0.006 per plant are based on the cost of shipping full trucks from Saskatchewan to California.

The cost of producing plug plants has not been determined for this report. The plants would have to be produced for part of the year in greenhouses and then moved outside so that they would be exposed to the conditions that produce northern vigour. There would be a large expenditure on labour and materials to harvest the plantlets produced on the tissue culture mothers in the greenhouse and place them in plug containers. Weed control

costs should be negligible although there would be opportunity for weed infestations of the plug containers during the period the plants are outside unless field covers were used. Processing would be minimal, but storage and transportation costs would increase because of the increased bulk of the plug containers. Moving plants in a planting medium rather than bareroot across international, state and county boundaries could prove difficult from a regulatory perspective. A very important issue would be whether northern vigour would be exhibited in these plants when planted for fruit production in California.

7.3.5. Fertility

If productivity can be increased through better fertility management, this is one of the least technologically difficult and least expensive options available, especially in a high value crop such as strawberry plants. In 2000, SSPP's soil test results suggested that about 90 lb/acre of nitrogen should be added to the soil at Pike Lake. In fact, SSPP added a total of 170 to 200 lb/acre of nitrogen over three to four applications, depending on the row. Even then, the plants in many parts of the field, especially the very sandy areas, appeared somewhat lacking in nutrients. The varying soil types and fertility across the field appeared to have a large effect on productivity from a visual perspective although comparative yield measurements were not gathered. The method of fertilizer application may have been somewhat inefficient, since the hand spreaders used did not accurately and evenly cover the targeted area and watering in of the fertilizer was delayed on at least one occasion. However, it appeared as if strawberry plants grown for multiplication purposes may have a higher need for nutrients than the soil test recommendations suggest.

University fertility trials in 2000 and 2001 tested nitrogen applications of 100, 150, 200 and 250 lb/acre. The results suggest that 200 lb/acre of N is most beneficial and 250 lb/acre N may be detrimental to production of total and marketable daughters.

The cost of nitrogen typically can range between C $0.25 and $0.30/lb. At applications of 200 lb/acre, the cost of $50 to $60/acre is quite minimal relative to other production costs. Even if the costs of fertilizer and application were to double due to the use of more expensive formulations, specialized equipment and more split applications, increased daughter plant production of 5% or less would cover the increased costs.

Determining the best quality of land and water for strawberry plant production will be an important part of supplying optimal levels of nutrients to the plants. Some of the Saskatchewan fertility tests have been carried out on high pH (above 8.3) land. 'Camarosa' in particular is very sensitive to pH and cannot absorb nutrients well when planted in high pH soil. Determining the requirements for phosphorus and other nutrients also will be important research work in the future. Timing and method of application are two other areas of research that need to be addressed. It will be important to optimize the placement and amount of nutrients available to rooting daughter plants as late into the season as possible without interfering with those environmental influences that affect the development of northern vigour and enable early harvest.

7.3.6. Herbicide Trials

Strawberry fruit growers do not want to buy nursery plants that have been exposed to herbicides. Certification regulations for nursery plants in other jurisdictions ban or restrict the use of herbicides of any sort during the growing season. Weed control is achieved through pre-plant fumigation and mechanical or hand weed control. Even in strawberry fruit production in the target market of California very few herbicides are used during the growing season. The looming ban on the use of methyl bromide for fumigation has spurred research in California into the use of alternative fumigants. Research is also being carried out on the use of low rates of in-crop applications of various herbicides (Manning and Fennimore, 2001). These tests, so far as is known by the authors, have only been carried out in fruiting fields, but perhaps there may be some future applicability to nurseries.

Various brands of trifluralin are registered for pre-plant use in strawberries in Canada. The University of Saskatchewan researchers have carried out two years of trials on the effect on daughter production of applying a trifluralin pre-planting (Treflan EC®, Trademark of Dow AgroSciences). The results have been mixed. In 2000, there was a significantly higher number of daughter plants produced when the soil was treated with the recommended rate of Treflan EC®. In 2001, the control had significantly higher numbers of daughters, but there were problems with the planting material and soil quality. The researchers suggest that the combination of prior plant stress and high soil pH with exposure to Treflan EC® may have affected the productivity of the plants in treated soil more than the other plants.

The contribution of trifluralin to increasing plant productivity likely would be from reducing weed competition and reducing damage to rooting strawberry daughters by replacing hand or mechanical weeding. Even if the use of trifluralin does not actually increase daughter plant production, its use would be economically beneficial. Trifluralin controls a wide spectrum of weeds, many of which were major problem weeds for SSPP in 2000 (especially wild oats, green foxtail and pigweed).

One of SSPP's largest costs in 2000 was weeding labour (over $2000 per acre for contract and hourly labour and management related to weeding). Although this was very high for a variety of reasons described elsewhere in this report, weeding costs even in fumigated fields are reported to be $500 to $1000 per acre (personal communication, various eastern Canadian producers). Treflan EC® costs $11.61 per acre at the recommended rate of .93 L/acre (Saskatchewan Wheat Pool, 2002). Custom application would cost about $5/acre and two disking operations would cost about $14/acre. For a total cost of about $30/acre, it is estimated that the total costs of weeding might be reduced by as much as one third if trifluralin was used prior to planting ($175 to $700/acre). However, trifluralin inhibits growth of roots and shoots and, thus, may be of particular concern to plant customers. Many of them worry that herbicide damage may carry over into the transplanted daughter plants, affecting plant vigour and, therefore, fruit production. Whether these concerns are rooted in fact is not really relevant, if the

customers believe there is any potential for such damage and look for plants elsewhere that have not been exposed to herbicides.

7.3.7. Two Year Production Cycle

University of Saskatchewan researchers have initiated a number of experiments looking at the potential of producing daughter plants on a two-year production cycle. Mother plants can produce significantly more runners in the second year of production than in the first year of production (Krieger and Tanino, December 2001). There are various methods of production that could be used in a two-year cycle, including:

- the mother plants could be kept for two years and the daughters harvested in each year;
- the mother plants could be kept for two years with two years growth of daughters harvested in the second year; and,
- the mother plants could be removed at the end of year one and the first year daughters allowed to multiply in year two before harvesting them and their offspring.

The results of the university research in this area so far are inconclusive. There have been difficulties with over-wintering the plants successfully, deer damage, stressed planting material, and inconsistencies between study sites. Even if there is not enough yield information to carry out an economic analysis, there are a number of production, regulatory and marketing issues that can be identified as potentially impacting the economics of a two year production cycle.

7.3.7.a. Reduced Costs of Production, Increased Yields

- Mother plants would only have to be purchased every two years. Mother plants cost SSPP over $850/acre in 2000.
- The planting operation would only have to be carried out every other year. The planting operation cost SSPP over $500/acre in 2000.

- In one of the proposed two-year systems of production, the results of two years of multiplication could be harvested in one harvest since both mothers and first year daughters would be allowed to overwinter. In-field harvest costs for SSPP were about $150/acre in 2000.
- If the daughter plants from the first year are left to overwinter, there should be a very large increase in the number of daughter plants in a given area the second year as each of the first year daughters produces its own crop of daughters. The first year daughters that become mother plants in the second year will have to be disposed of at harvest because they are unlikely to be accepted by customers as suitable for transplanting, just as first year mothers are usually disposed of.
- There is a possibility that fruit could be harvested and sold in the second year of production. It would be very important to determine whether the economic benefit of selling fruit exceeded any potential loss in runner production resulting from the diversion of mother plant energy to fruit production.

7.3.7.b. Increased Costs of Production, Reduced Yields

- In two of the proposed two-year systems, either the first year daughters or the mother plants would be removed at the end of the first season. Harvest equipment and planting regimes would have to be modified to accomplish this without damaging the plants left in the ground. In Nova Scotia, one producer only harvests the daughter plants, cutting them away from the mothers, but to accomplish this he drives on the mothers since he is going to dispose of them anyway. While mothers that survive the winter may have higher yields in the second year, it is known that mother plants have a higher mortality rate over the winter than daughter plants (Turner et al., 1993). Dead plant material left in the beds could encourage disease and pests in the second year. There would be some loss of daughter plants as the mother plants were cut out of the row, since runners often turn into the mother plant row and root there.
- Strawberry plants must be mulched in order to overwinter successfully. Manitoba Agriculture (1995) estimated the cost of straw mulch, application and removal at $260/acre. Even with mulching there are sometimes heavy losses of plants over

winter. Two-year systems that market no plants in the first year would be a greater financial risk than a one-year system.

- There is potential for extreme crowding of plants in the second year if all of the first year daughters are allowed to multiply. Crowding may reduce the size and rooting success of the second year daughters. The original planting regime and the manner in which daughter plants are set in the first year may have to be changed to accommodate the increased plant density in the second year.
- Insecticides and fungicides have not been required in strawberry plant production thus far in Saskatchewan. Leaving strawberry plants in place for two years increases the potential for pest problems and therefore, the potential for either having to use expensive controls or suffer yield losses. Entire two-year crops could be lost if there were, for instance, a nematode infestation that was able to expand to critical levels because of the long period the plants were in place.
- Financial and human capital investments made in the crop in the first year will not be offset by income until the end of the second year in systems that harvest only once in two years.

7.3.7.c. Other Potential Changes

- It is unknown what the effect on the development of northern vigour in southern strawberry cultivars will be if they are overwintered and multiplied for a second year in Saskatchewan.
- Weed control costs could increase or decrease:
    - good weed control in the first year might decrease the populations of weeds and the cost of controlling them in the second year; the opposite could also happen if certain weeds become established in the first year.
    - the greater vigour and mass of the overwintered strawberry plants from the beginning of the second season would compete better with weeds.
    - there may be a requirement for more hand weeding. It is difficult to use either mechanical weeding or hand-tools among strawberry plants that have spread out. Even in the first year, the cost of each successive weeding increases as

the plants spread out and become bushier, necessitating more handwork. The cost of SSSP's third weeding in 2000 was three times the cost of the first and much harder labour. It was, therefore, harder to retain labourers.

- Fertilizer trials would have to be conducted to determine if there were differences in the fertilizer requirements of a two-year system.

7.3.7.d. Regulatory and Marketing Issues

Second year offspring of registered plants are not considered certified plants in the California certification program. They are common stock. It is not clear how much of the nursery stock sold in California is sold as common stock. According to one source, a large percentage of high elevation plants are multiplied to the common stock level and are acceptable to fruit producers. (These plants would not be second year offspring of registered plants but first year daughters of certified level plants). However, bringing uncertified plants or plants certified under different rules into California from another jurisdiction may not be acceptable to the state and county regulators.

Southern California fruit producers do not seem to be very concerned about the technicalities of certification status, but they would be concerned about the potential for disease and pest build-up over a two-year production cycle. California nursery owners could certainly create problems for plants grown in a two-year system if they thought their markets were threatened. Overcoming regulatory hurdles and gaining customer acceptance would be a major part of developing as two-year production cycle.

Section 8. Conclusions and Recommendations

This section presents conclusions and makes recommendations based on research that has been carried out over the last two years on the economic potential for production of "northern vigour" strawberry plants in Saskatchewan. This research is a continuation and expansion of the research presented in two previous economic studies (Lokken, Brown, Taylor, Tanino, Bandara and Ward, 1998; Lokken, Storey, Allen and Tanino, 2000). The impetus for this economic research arose from the promising results of the ongoing horticultural research on northern vigour in Saskatchewan-grown strawberry plants conducted under the direction of Dr. Karen Tanino of the University of Saskatchewan and supported by the Province of Saskatchewan.

The main purpose of the project was to extend the economic research and business analysis begun in the previous studies, focusing on commercialization of strawberry plant production in Saskatchewan. As stated in the original project proposal presented to ADF "... continuing field work to increase crown yield must be accompanied by economic and business analysis to maintain the momentum which has been built upon in terms of California strawberry plant and fruit growers' interest in the Saskatchewan product and to provide a sound framework for economic Saskatchewan production. In order to be timely and successful the preliminary economic feasibility work must be carried out jointly with the field experiments (ADF Project Proposal #19990185)."

Much of the research in the current economic study has focused on describing and analyzing the Saskatchewan Strawberry Plant Producers (SSPP) commercialization operation that produced strawberry plants for sale to California in 2000. Access to the production and marketing records of this private operation has provided a unique opportunity to advance the economic research on northern vigour strawberry plants. The research was able to move forward from relying on experimental plot results and data from other areas of North America, to being able to analyse an actual commercial

enterprise producing in Saskatchewan conditions and marketing into a competitive marketplace. Because of the activities of SSPP, the results of this ADF project far exceed what would have otherwise have been possible in terms of meeting the project objectives.

The commercialization project carried out by SSPP in 2000 failed if looked at from an annual financial analysis. Expenses far exceeded revenues and production did not continue in 2001. However, the enterprise succeeded in most areas of production and marketing, indicating potential for future production in the province. Solutions to many of the difficulties that increased expenses and lowered revenues in the inaugural year exist and have been described in this report. Some problems such as the heavy frosts that damaged the crop can occur in any year, but can be managed better in terms of timing and practices. Labour costs and market access (regulatory hurdles) remain the most worrisome issues for a future industry. SSPP's activities can serve as guidelines for future commercial production of strawberry plants in Saskatchewan for the US market. SSPP's experience has also helped to provide a better focus for horticultural and economic research that is already in progress and for identifying and determining the relative priority of new areas of research.

Other work was carried out over the course of the current project that was not directly connected with the business activities of SSPP. The researchers invested time and resources into educating southern California strawberry fruit growers about the research being carried out in Saskatchewan and the benefits this research may offer them. This extension of information took place in a series of meetings in February 2000 in southern California, during a visit by some of these fruit growers to Saskatchewan in September 2000 and, again, when one of the researchers visited California in March 2001. It continues through ongoing communication between the researchers and fruit growers. Information continues to be collected from these growers and from California nurseries on the production and marketing of strawberry plants in California. Lines of communication have been established with public agencies in California involved in strawberry plant production and marketing, especially the California Strawberry Commission, the University of California Office of Technology Transfer which deals

with patent rights, the University of California Foundation Plant Material Service which maintains nuclear stock of California varieties, and various branches of the California Department of Food and Agriculture. Contacts that have been developed over the course of this research and during the preceding research projects also have been maintained in the Canadian provinces that produce strawberry plants and in Florida where there is future market potential.

The researchers have also addressed the requirements for developing a closed system of plant certification in Saskatchewan that would diminish dependence on outside sources of plant material and the economic potential of production of northern varieties of strawberry plants. A number of experimental yield-enhancing techniques for plant production currently being researched at the University of Saskatchewan such as field covers, fumigation, herbicide use, hormone dips, tissue culturing, two year production cycles and fertility trials also have been examined from an economic perspective. All of these areas of research will require further economic analysis as the underlying horticultural research evolves.

The analysis of the SSPP commercial operation and the other economic research work carried out in this study have answered many of the questions that were raised by the earlier economic studies. However, there are a number of production, marketing and regulatory issues that must be resolved before a major extension program should be launched for industry development. These are addressed in the following conclusions and recommendations.

8.1. Conclusions

Conclusion #1: Production and Marketing Feasibility
The production of strawberry nursery plants (crowns) in Saskatchewan for sale to southern California fruit growers has the potential to be economically feasible if key areas of concern are adequately addressed. This conclusion is based on the research results presented in Study 2 and the experience gained from the commercial SSPP operation in 2000.

There are a large number of production, harvesting, processing, regulatory and marketing issues that remain to be resolved but these do not appear to be insurmountable. This study describes these issues in detail and presents possible solutions to many of them. A number of these issues will only be solved over time as better information is acquired and experience is accumulated. Therefore, any prospective entrants into plant production in Saskatchewan must have a long-term perspective and must have the financial resources to carry them through an initial period where profitability may not be achieved.

There are several key areas of concern that must addressed before any further commercial production should occur in Saskatchewan. First, the yield of marketable and marketed daughter plants (number of marketable and marketed daughter plants per mother plant) must be improved. Second, an adequate source of affordable and sufficiently skilled labour must be identified so that required field and processing operations can be carried out in both a timely and economical manner. Third, there must be a decrease in the amount of risk attached to the process of satisfying State of California's rules and regulations regarding plant production and inspection. Fourth, prospective producers must negotiate sales of plants to California growers in advance of the beginning of production and must be able to deliver plants in good quality and on time as agreed upon. Fifth, California customers must be willing to purchase Saskatchewan plants for a premium price that reflects at least part of the extra economic returns from using northern vigour plants.

Conclusions #2 to #7 provide the basis for Conclusion #1.

Conclusion #2: Field Production Methods
Production research must focus on maximizing, within economic constraints, the plant multiplication rate (the number of marketable daughter plants produced per mother plant).

The term "marketable daughter plants," in the Saskatchewan context, refers to daughter plants that develop sufficient crown size, root development and chilling early enough in the fall to out-perform high elevation California plants in terms of early availability, good survivability, early fruit production and high fruit production over the production season. "Marketable plants" also refers to plants that are free of disease and pests and that exhibit other characteristics of superior vigour identified in the University of Saskatchewan research.

The current university research into yield improvements is an important part of the effort to improve yields of marketable plants. Research into the use of field covers to increase marketable yields has produced promising results. This type of system requires testing at a larger scale before its commercial practicality is confirmed. Fertility research and the use of hormone dips, tissue culturing, herbicides and two-year rotations may prove to have important commercial applications.

Soil fumigation is used by most North American plant producers to reduce disease and pests and to increase yields. The initial year of university research tests on fumigation did not show yield improvements with fumigation. However, there were problems with the planting material used in the experiment. More years of tests under better research conditions are required before useful conclusions can be drawn. It may be that Saskatchewan can produce without fumigation, although the SSPP problem with nematodes creates uncertainty about this. However, production economics, regulatory regimes, risk management, and customer preference may push Saskatchewan toward the use of fumigation. Continuing the university fumigation research and training provincial personnel in nematode identification and testing are important.

It is expected that the multiplication rate can be increased through better knowledge of the requirements for soil quality, soil fertility, water quality and watering regimes, and

through improvements in field design, planting techniques, weed control and runner setting. It is known that a sandy loam soil that has good levels of organic matter and water retention capability both supports plant growth and provides for ease of harvesting. The irrigation regime is very important in the promotion of optimal plant growth and rooting of runners. The effect of the pH level of irrigation water on productivity is a factor that needs to be further explored. It is critical to ensure that the primary daughter plants root quickly. The methods used to accomplish this may include optimal irrigation timing, better methods of hand setting runners, and the use of mechanical means of runner setting.

Maximizing the amount of the total acreage that is available for runner rooting is important. The double row planting method used by SSPP in 2000 where runners were turned back into the double row left too much land unused. Many nurseries in California use a solid set method of planting where runners are allowed to root in all directions and fill the entire available space.

Conclusion #3: Processing and Shipping Methods
Research in this area must focus on methods of trimming, packing and shipping plants with the objective of maximizing, within economic constraints, the number of successfully marketed plants.

There is uncertainty about how best to process and store plants and deliver them to California. California nurseries, given their operational size and location, are able to harvest, trim and deliver plants to southern California growers in three days. This is what California growers want. Saskatchewan's distance from market and uncertain labour supply likely will not allow competition with California on the basis of time to market. It would be theoretically possible for a load of plants to reach southern California with plants that have only been out of the ground for three days, but this will be unlikely, especially in the early years of a Saskatchewan industry when the scale of production and processing probably will be small. The minimum time from Saskatchewan field to California field would more likely be one week. It will be difficult to amass the volume of labour required for more rapid processing, unless there are a number of Saskatchewan nurseries that pool their shipments so they would be able to ship more often and reduce

the storage period. The strawberry nurseries in Nova Scotia do this for shipments in Florida.

There were a number of places in the harvesting and processing operation where marketable plants were lost. Mowing plants in the field prior to digging left the mowed plants more susceptible to frost damage. SSPP was not paid for about twenty five percent of the plants it shipped in 2000 because they did not survive transplanting in California. Almost certainly the main cause of the loss was frost damage. The harvesting machine used by SSPP did not do a good job of removing soil from the roots of the plants. This meant that the whole processing operation was slowed down and plants were damaged when large amounts of soil had to be dealt with during unloading at the trimming facility and when plant trimmers had to remove excess soil from plant roots. Trimming was carried out at too high a standard so that many marketable plants were discarded (possibly as many as thirty percent). Many plants likely were damaged by poor pre-trimming storage and lengthy periods of exposure to dry air between trimming and packing. It is important that plants be cooled as fast as possible after packing. Active methods of drawing off heat should be used to accomplish this. California nurseries use perforated plastic box liners and perforated cardboard boxes so that plants can be adequately cooled, rather than the sealed liners and solid cardboard boxes used by SSPP in 2000. The right amount of moisture must be maintained in the boxes so that plants are not overly wet (they will mold) but care also must be taken so that plants do not dry out, especially during the longer storage and transportation period to which Saskatchewan plants will be subject.

A Saskatchewan nursery should be prepared to ship a load of plants at least twice each week during harvest, unless it can be shown to the satisfaction of California customers that holding early-dug plants in a cooler does not affect plant quality and condition. The research on this issue has not been carried out to date. Plants must be shipped in a refrigerated reefer capable of holding plants at 0 degrees C. The nursery must install its own temperature monitoring devices in each truckload. In most cases the plants will be delivered to a company with cooling facilities according to arrangements made with the

customers. There will be a charge for this service paid either by the nursery or grower. Agreement on this point must be part of the original sales agreement. It is likely that the county inspector will inspect the shipment of plants either on the truck on in the cooler before they are released to the growers.

Conclusion #4: Labour Supply
An adequate source of affordable and sufficiently skilled labour must be identified so that the required field and processing operations can be carried out in both a timely and economical manner.

Labour was the biggest SSPP expenditure in 2000. Finding and keeping quality labour was a problem throughout the season. There does not seem to be a large pool of capable people willing to engage in this type of hand labour in Saskatchewan. Perhaps contracting with groups such as Hutterites, sports teams or service clubs that may bring a positive group dynamic to the required tasks, rather than hiring individuals randomly, may be one solution to the labour issue. Arranging most labour on a piecework contract basis rather than by the hour should also improve efficiency.

Effective management of the labour that was procured in 2000 also was a major problem. This will improve with experience both in managing people and with better knowledge of the requirements of the production process. For example, employing a small number of weeding labourers continually through the season may have been more efficient than the use of large gangs of weeding labor at times when the weeds were becoming difficult to handle.

Trimming labour was particularly a problem in 2000. The productivity of the trimming labour was much lower than had been estimated originally. It was difficult to develop and implement effective labour management strategies given the lack of experience and the shortened processing time frame available because of the nematode problem and resulting harvest delay. Efficient use of processing labour will require improvements in the physical layout and methods used in processing and the development of appropriate training procedures and production incentives. The number of plants trimmed per worker must triple from SSPP's results in 2000 to around 3000 plants per worker per shift.

Conclusion #5: Regulatory Issues
Saskatchewan nurseries must be confident that they can meet California's regulatory requirements consistently. Acceptance of Saskatchewan plants by California officials must occur before the plants reach their destination. Leaving the approval to county officials at the point of unloading is a risk that a developing strawberry plant industry cannot afford. Current California inspection conditions, unless improved, will hinder the development of a production industry here.

California regulations regarding plant inspection remain as one of the largest uncertainties that a Saskatchewan nursery faces. While the commercial operation in 2000 did not encounter difficulties even after informing county officials of the potential presence of nematodes in the shipment, there is no guarantee that there will be no difficulties in the future. The problem is that if shipped plants do not meet the county inspector's approval regarding freedom from disease, insects, soil etc. they are likely to be kept under quarantine for a week or more while tests are conducted. This delay is likely to make the plants non-saleable. It will be important to achieve an agreement where Saskatchewan nurseries have the same status as nurseries in California whose products are exempt from county inspection. This will likely require inter-government communication between Saskatchewan and California and the development of a regulated certification system in the province.

Conclusion #6: Marketing to Southern California Growers
Southern California growers are interested in using Saskatchewan as a new source of plants provided that Saskatchewan growers are able to meet their requirements in terms of plant quality and delivery conditions.

Southern California growers are interested, in particular, in obtaining plants earlier than they can now obtain them from California growers. Growers south of Los Angeles likely want plants in mid to late September and growers in the Oxnard area want plants in late September and early October.

Even with the problems encountered with Saskatchewan plants in 2000, most of the growers who purchased plants indicate that they would be willing to purchase Saskatchewan plants again. However, they could easily lose interest if the harvesting, packaging and shipping problems of 2000 are not quickly solved. They indicate that they

lo not have much patience with nurseries that have problems. However, it is known that hey have stood by more than one nursery through a series of bad years, especially if they eel that nursery has the potential for improvement.

Conclusion #7: Price Premiums for Saskatchewan Plants
Saskatchewan growers must be able to obtain a price premium for Saskatchewan plants relative to the price paid for the best high elevation California plants.

Saskatchewan nurseries are unlikely to be able to compete on price with California nurseries, even with a low-valued Canadian dollar. Saskatchewan's disadvantages include high labour costs, low plant productivity, long distance from market and lack of production experience. The premise of the current economic research is based on the Northern Vigour research results. If Saskatchewan plants are consistently superior to the best California plants in terms of early availability, early yield, season-long yield, and freedom from disease and pests, they should command a price premium.

In 2000, SSPP obtained a 50 percent premium based on test results of Saskatchewan plants in 1999 and earlier. However, it may be difficult to maintain this level of premium since plot and field test results in 2000 and 2001 have not shown the same yield advantage for Saskatchewan plants. It will be extremely important that further tests establish the consistent superiority of Saskatchewan plants and, thus, justify a price premium, if production in Saskatchewan is to be economical.

Conclusion #8: Introduction of New Varieties
Saskatchewan strawberry plant production destined for California is vulnerable to losing market share to new patented strawberry varieties available only to California nurseries in the first years after release.

Under current regulations, newly licensed varieties introduced by the University of California are made available to California nurseries and fruit growers only for the first two years after release. If the new variety is clearly superior to existing varieties there can be a large demand for the new variety, putting out-of-state nurseries that cannot supply it at a disadvantage.

Conclusion #11: Production of Northern Varieties
The production of northern varieties of strawberry plants to sell into markets across Canada and the United States is of secondary interest to Saskatchewan.

The market for northern varieties is much smaller than the market for southern varieties. Northern varieties are sold for significantly less than southern varieties. They also require storage over winter because they would be fall-dug in Saskatchewan and customers would not want them until spring. Production of northern varieties probably would only be attractive if it was done as an adjunct enterprise in a nursery operation whose main business was the production of southern varieties. Long-term storage facilities might be required for the production of southern varieties if a closed certification system is developed where parent material would have to be carried over the winter. The costs of developing such storage could then be shared between the two enterprises.

Conclusion #12: Public Horticulture and Economic Research
Further publicly-funded horticultural and economic research remains necessary at this point in time.

There are many reasons that point to the usefulness of further public support for research in this area. Given that test results from California in the past two years have not consistently shown the yield advantage for Saskatchewan plants observed in earlier test years, it is necessary to invest resources in conclusively establishing which attributes of northern vigour are consistently exhibited in Saskatchewan plants and at what levels. The economic potential of a nursery industry in Saskatchewan depends on the production of a superior plant that will attract a price premium.

The results of the commercial activities of SSPP provide a focus for further public research into commercialization. Saskatchewan must capitalize on this opportunity. The horticulture research is in the midst of testing a number of yield-enhancing techniques that appear as if they will have positive economic impacts on plant production in the province. Other provinces, Alberta in particular, are starting to investigate the potential for production of northern vigour plants. Saskatchewan will have to continue to support

research and develop producer information if it is to maintain its place as the leader in this research.

8.2. Recommendations

Recommendation #1: Southern California Field Trials
Continue field trials of Saskatchewan-grown plants in Southern California.

It is imperative that trials of Saskatchewan-grown plants be continued annually in southern California. These trials should be maintained with growers who have the interest and capability of making accurate assessments such as Chas Nakama at Oxnard and Bill Ito/Steve Ozawa at Irvine. These growers have cooperated in trials for several years. Other of the SSPP customers can perhaps be enlisted to cooperate in further trials if they are willing to keep the necessary records. The primary purpose of the trials must remain the quantification and demonstration of the attributes of northern vigour in Saskatchewan plants that make them attractive to California fruit growers.

Recommendation #2: Other Field Trials
Begin research trials in other parts of California and other areas of the southern U.S.

Research trials should be arranged further north in California and in Florida. It is important to find out what advantages Saskatchewan plants may offer to producers in areas other than southern California. One grower, Jack Gresser, in the Santa Maria area (about one hundred miles north of Oxnard) has expressed some interest in cooperating in trials there and at production facilities he is involved with in Florida. There are other opportunities for trials in Florida also. There may also be opportunities in other southern states such as North Carolina and Louisiana.

Recommendation #3: New Strawberry Cultivars
Begin testing of new California and Florida strawberry cultivars for northern vigour as soon as they are available. Work on developing suitable Saskatchewan cultivars.

The University of California released new patented strawberry cultivars in 2001. These cultivars will not be available to growers outside of California until at least 2003.

However, they should be obtained for university research purposes earlier if this is possible, so that the Saskatchewan research keeps up with trends in California. The new variety 'Ventana' may turn out to be a major replacement for Camarosa. It is especially important that this variety be tested for its northern vigour response to multiplication in Saskatchewan. Cultivars from Florida's strawberry breeding program should also be investigated. Over time, the breeding work at the University of Saskatchewan may produce cultivars that are attractive to southern US fruit growers. Such a development would put a Saskatchewan industry in a very strong market position.

Recommendation #4: Industry Intelligence and Market Development
Continue to develop contacts with researchers and plant and fruit producers across North America. Continue to gather and analyze production, economic and market information.

There is still a requirement for government financial support for the collection and analysis of production, economic and marketing information on strawberry plants from across North America and even further afield. There are a number of facets of California plant production and marketing that need to be further explored before there is an adequate understanding of the situation there. A detailed economic and marketing assessment of the Florida market for green plants and Saskatchewan's potential to service this market should be commissioned. This assessment will require at least one visit to Florida to directly assess the interest in Saskatchewan-grown plants and further develop connections to the industry there that have been initiated over the course of the current research. Assessments of other markets for southern plants in the United States should be carried out at this time also (North Carolina, Louisiana, etc.). Perhaps government and private interests can cooperate in funding visits by prospective growers to production and market areas to maintain and enhance the initial market development that has already occurred.

Recommendation #5: Regulations
Begin to plan appropriate regulations and inspection regimes in Saskatchewan and pursue favourable California regulatory status for Saskatchewan plants.

A concerted effort is required to begin the process to place Saskatchewan-based nurseries on the same inspection basis as California-based nurseries. The goal of this initiative would be that plants harvested in Saskatchewan would be approved for importation into individual California counties before they are processed and shipped. This is the current situation for California nurseries. Provincial government representatives will have to develop working relationships with the California state authorities who are responsible for plant inspection. The development of a provincial inspection and certification system that meets the demands of customers will be required.

Recommendation #6: Production and Processing
Develop commercial production and processing methods and practices suitable for Saskatchewan, with emphasis on:

- *Plant Productivity*
- *Field Production Methods and Practices*
- *Nematode Testing and Fumigation*
- *Harvesting Machinery*
- *Processing, Packing and Shipping Methods and Practices*
- *Labour Requirements and Sourcing*

A wide variety of experimentation in the areas of plant productivity and commercial production and processing methods still is required to develop an efficient commercial production system suitable for Saskatchewan. Some of this research is presently underway at the university, while SSPP initiated some of this research privately. However, SSPP is not presently undertaking any research or production activities.

Much of the necessary production knowledge will only be gained over time through commercial production experience. Hopefully, there will be producers in the province who are able to invest the time and financial resources to develop technically and economically viable production operations and who will share information with other Saskatchewan producers and public researchers. However, extensive public research in production research also will be required for some time. It will be necessary to determine the priorities for public research, so that public money can be allocated wisely and

without discouraging private initiative. The following are some areas of research where further public research is required:

Recommendation #6a: Plant productivity

Experiments on increasing plant productivity through the use of mulches, field covers, fumigation, hormone dips, fertility trials, tissue culturing and two year production cycles should continue at the university. The university research should also have the capability to examine new trends in the industry such as plug production of nursery plants. As the various areas of research evolve, the economic implications will need to be further described.

Recommendation #6b: Planting regimes

Research tests are required to determine the best planting regimes for obtaining increases in the number of marketable plants and for efficiency of production. These include tests on spacing, fertilization, runner setting methods and others. There is still much to be learned about optimum planting densities and planting configurations that maximize the use of land while allowing efficient control of weeds, reducing the amount of hand setting and increasing the effectiveness of the hand setting that must be done.

Recommendation #6c: Nematode testing and fumigation

Extensive field testing is required on various Saskatchewan soils and crops (crop residues) to determine the types and levels of soil and plant nematodes and the need for fumigation. The tests must be carried out to the species level. The test procedures should conform to those used in California and other potential markets such as Florida. This will require the development of professional skills and acquisition of suitable technology. This development process has already begun with the training of a provincial laboratory staff person in California in early 2002 and the scheduled visit of a California government nematologist to Saskatchewan in April 2002.

Nematode tests should also be carried out on any plant material that is brought from California for testing. This should become a standard practice if there is commercial nursery production in the province that depends on parent material from California.

Recommendation #6d: Harvesting machinery

Research efforts should be directed to developing a suitable harvester. The harvester is a very important component of successful commercial production. The design of the harvester will have some impact on the planting configuration. The wheel spacing of the mint harvester available to SSPP in 2000 suggested the double-row planting configuration used by SSPP. This planting configuration was not optimal in terms of land use or labour efficiency. The mint harvester used in 2000 also did not provide sufficient agitation during the harvesting process, leaving too much soil on the plants. This caused serious transportation and processing problems.

There are a number of possibilities for developing a suitable harvesting machine. A mint digger similar to that used by SSPP in 2000 could be modified, a used strawberry plant digger from another area could be purchased and modified for Saskatchewan conditions (the machine owned by the New Brunswick government may be available) or a completely new harvester suitable for Saskatchewan conditions could be developed. The plans for the New Brunswick harvester were provided in *Study 2.*

Recommendation #6e: Processing, Packing and shipping

Tests to determine what level of moisture and temperature stress plants can endure from field through the processing operation to packing are required. Optimal post-processing storage conditions also must be determined. This will involve experimenting with various types of liners and boxes to find those that maintain the correct level of moisture and are acceptable to customers. Similar information on storage temperatures must be determined. Ongoing tests must be continued on the effect of storage period and conditions on early-dug plants, since

the ability to dig plants early and successfully store them for the period of time it takes to move them to California from Saskatchewan is crucial to an industry here.

Recommendation #6f: Labour requirements and sourcing

Given that labour availability and skill is one of the constraints to a strawberry nursery industry in Saskatchewan, additional work needs to be undertaken to develop a solution to this problem. Potential sources of labour must be identified and labour management strategies developed. Research is required on the development of efficient weed control systems and processing operation layouts, as well as productivity incentives for workers.

Recommendation #7: Closed certification system

Continue research on a closed certification system in Saskatchewan.

Research should continue on the need and requirements for developing a provincial certification system that maintains its own virus-free nuclear or foundation stock. The necessity and economic feasibility for this will only become clear over time as an industry begins to develop in Saskatchewan.

Recommendation #8: Northern variety production

Continue research into the production, storage and marketing of northern varieties.

Research into the production, storage and marketing of northern varieties should be carried out as an adjunct to the primary research on developing markets in the United States for southern varieties that exhibit northern vigour. The commercial production of northern varieties in Saskatchewan will likely develop as a subsidiary activity to the production of southern plants because of the limited market size, lower price and requirement for long-term storage

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Appendix A. Nematode Sampling Requirements and Correspondence: SSPP 2000

SSPP sampled its strawberry nursery field in late August 2000 according to the California regulations for nematode testing of unfumigated nursery fields. (California Department of Food and Agriculture, 1986). Representatives of SAF, CFIA and the University of Saskatchewan were present as observers (see Ayars letter, page 188).

The laboratory report from the Pest Diagnostic Clinic at the University of Guelph came back positive for several types of nematodes just as SSPP was about to begin harvest on September 24. Unfortunately, the test was only carried out to the genus level whereas California rates nematodes at the species level. Different species within the same genus can be considered harmless or absolutely unacceptable according to California regulations. The SSPP partners were in a quandry as to what to do – harvest or abandon the project. Dr. John Potter, nematologist with AAFC was asked to retest the sample to the species level which he did in a very short time and in consultation with Dr. John Chitumbar of the CDFA. The re-testing showed that the nematodes in the SSPP nursery stock were relatively harmless. However, the decision to allow the plants into the two counties they were destined for in California would be left to the discretion of the county inspectors. SSPP decided to go ahead with harvest a week later than planned and kept the California inspectors aware of the situation. The plants were accepted without problems when they arrived at the county inspection stations, but the loss of a week of harvest was very damaging to SSPP.

Appendix A presents:

- CDFA: Nematology Pest Rating Lists.
- CDFA Sampling Procedure and Technique for Detection of Nematodes by Laboratory Examination (required for unfumigated nursery fields).
- Letter from Morley Ayars, SAF, attesting to his observation of the field sampling procedure used by SSPP.

- University of Guelph Pest Diagnostic Clinic Report on SSPP's sample, September 22, 2000.
- Letter from Dr. John Potter, AAFC nematologist, regarding his findings from the sample test to the species level.
- Second Pest Diagnostic Clinic report based on based on the findings of Dr. Potter.

NEMATOLOGY HIGHLIGHTS

NEMATODE PEST RATING LISTS

It is the general policy of the Department of Food and Agriculture to assign a pest rating to those organisms which could have economic effects on the agricultural systems of the state. In brief, the following guidelines are the basis for these pest ratings and in turn the meaning of each rating is discussed. The pest rating list has recently been revised for the nematodes of concern to California, and it will be included on the next several pages for the particular use of the Agricultural Commissioners. The list is in two parts, alphabetically by species, and in order by rating. The list is included here at the end of this issue so that the pages may be removed and used separately as needed.

Plant Industry
Guidelines for Establishing or Changing Pest Ratings

I. GENERAL PRINCIPLES

Section 403 of the California Food and Agricultural Code mandates that, "The department shall prevent the introduction and spread of injurious insect or animal pests, plant diseases, and noxious weeds." This statutory duty requires a pest policy which recognizes that organisms vary as to their potential and actual harm to California's agriculture and environment. Overall pest significance is the basis for determining what pest prevention activities are appropriate, at what level, and when and where those activities should be conducted.

A. Pest ratings are intended as aids to inform county agricultural commissioners and other interested persons as to a particular pest's environmental, agricultural and biological significance, as well as its importance to the general public, and the action recommended by the Department to deal with the pest.

B. Each pest rating represents the Department's view of the statewide importance of the pest to the agricultural, horticultural, forestry, and public health interests of California. Local conditions may dictate more stringent action against the same pest in individual counties at the discretion of the county agricultural commissioner.

C. It is the Department's policy to use the "Action Oriented Rating System". Pest ratings represent the Department's policy governing what action is to be taken consistent with existing statutes which include authority for: the promulgation of quarantine, eradication, control, standards of cleanliness, and other regulations; holding and inspection; establishing host-free, weed-free, and special pest control districts; and for other regulatory activities.

II. ACTION ORIENTED RATING SYSTEM

DEFINITIONS

"A" An organism of known economic importance subject to state (or commissioner when acting as a state agent) enforced action involving: eradication, quarantine regulation, containment, rejection, or other holding action.

"Q" An organism or disorder requiring a temporary "A" action pending determination of a permanent rating. The organism is suspected to be of economic importance but its status is uncertain because of incomplete identification or inadequate information.

In the case of an established infestation, at the discretion of the Director, the Department may conduct surveys and may convene the Division Pest Study Team to determine a permanent rating.

"B" An organism of known economic importance subject to: eradication, containment, control or other holding action at the discretion of the individual county agricultural commissioner.

or

An organism of known economic importance subject to state endorsed holding action and eradication only when found in a nursery.

"C" An organism subject to no state enforced action outside of nurseries except to retard spread. At the discretion of the county agricultural commissioner.

or

An organism subject to no state enforced action except to provide for pest cleanliness in nurseries.

"D" No action. (Parasites, predators, and organisms of little or no economic importance).

STATE OF CALIFORNIA

DEPARTMENT OF FOOD AND AGRICULTURE

Pest Exclusion/Nursery Programs
1220 N Street
Sacramento, CA 95814

SAMPLING PROCEDURE AND TECHNIQUES FOR DETECTION OF NEMATODES BY LABORATORY EXAMINATION

In accordance with the terms of the Regulation for Nursery Inspection, the Department of Food and Agriculture hereby specifies sampling requirements and procedures for detection of nematode pest infestations in field, container, flat, and frame grown nursery stock.

Where inspection for the detection of nematodes using laboratory methods is a requirement, sampling procedures shall be as follows:

1. Field grown nursery stock - generally. Collect root samples before digging time on a 40-foot (12 meter) grid interval throughout the planting. To assure detection of dagger nematodes, root samples should include a small amount of the soil adhering to or along the feeder roots collected at each point. Samples may be composited on an acre (0.4 hectare) basis. Root and soil samples should be processed and examined separately.

2. Field grown nursery stock - special case. At the discretion of the commissioner, root samples may be collected on an 80-foot (24 meter) grid interval and composited on a two-acre (0.8 hectare) basis when both of the following conditions have been met:

   a. The growing ground has been fumigated at not less than 1,3-D hydrocarbon or methyl bromide product labeled rates for the kind of farm planting nursery stock being produced.

   b. No plant parasitic nematodes have been found either by laboratory or field inspection procedures in the previous two successive nursery crops on the growing ground.

3. Container, flat, and frame grown nursery stock. A composite sample from each lot is to be obtained by collecting roots from one plant in every 100 square feet (9 square meters) of bench or frame space. Care should be exercised to keep the lots down to logical and practical sizes.

4. Delimitation of nematode pests found in any planting may be made only as provided in the Nursery Inspection Regulation,

Section 3060.2(c). When delimitation is attempted, it is to be by resampling and use of laboratory methods. Delimitation sampling should be performed by collecting root/soil samples on a 20-foot (6 meter) grid interval throughout the infested parcel. Samples should be composited on a quarter-acre (0.1 hectare) basis. Further delimitation generally is not advisable; but, may be attempted at the Commissioner's discretion when he determines that an infestation is very limited and that little or no risk of releasing infested stock exists.

Similarly, container, flat, and frame grown lots should not be delimited. The latter should be unnecessary where initial sampling was of reasonable lot sizes.

Any delimitation effort which fails to recover the nematode originally detected should be considered as "safe" (see Section 3060.2(c)(2)) and all stock represented by the original sample should be released.

5. Approved bare root sampling and laboratory procedures are described by the Laboratory Services Unit in circulars entitled "Suggested Procedure for Sampling Bare Root Nursery Stock for Nematodes" and "Manual of Standard Procedures for County Plant Nematology Work".

Saskatchewan
Agriculture
and Food

EXTENSION SERVICE

3735 Thatcher Avenue
Saskatoon, Saskatchewan
S7K 2H6
(306) 933-6150 Phone
(306) 933-7352 Fax

October 6, 2000

To Whom It May Concern:

On August 30, 2000 I observed and participated in the collection of strawberry plant samples. These samples were collected from the ten acre strawberry plant nursery operated by Saskatchewan Strawberry Plant Producers at Saskatoon, Saskatchewan. These samples were collected for laboratory nematode testing according to the methodology laid out in the California Department of Food and Agriculture Nursery Regulations 3055.5b *Certification Based on Approved Laboratory Conditions*, (1) *Field Grown Nursery Stock, Generally.*

The samples were collected on a 40 foot x 40 foot grid interval throughout the planting. Samples were composited on a per acre basis. The entire field was of the Camarosa variety of strawberry.

Yours sincerely,

Morley Ayars, P.Ag.
Farm Management Agrologist

8

UNIVERSITY of GUELPH LABORATORY SERVICES

Report

PEST DIAGNOSTIC CLINIC
DIAGNOSTIC REPORT - NEMATODE

Date sample received: 00/09/01 **Lab I.D. #:** PDC00-1631 to PDC00-1640

Submitter: James Lokken
Saskatchewan Strawberry Plant Producers
410-9th Street East
Saskatoon, SK
S7N 0A8

Owner: **Host:** Strawberry
Cultivar: Camarosa (Primary crowns)

	Nematode Count from Roots		
	Nematode counts from soil = # of nematodes/01 gram of dry roots		*Aphelenchoides* species *
Field/Grower ID	Root Lesion	Spiral	Present (Yes/No)
1	51	20	Yes
2	137	6	Yes
3	178	3	Yes
4	36	12	Yes
5	7	0	Yes
6	96	4	Yes
7	3	6	No
8	48	13	Yes
9	11	5	Yes
10	23	0	Yes

Visit us on the web at www.uoguelph.ca/pdc

General thresholds for economic damage on most crops:
ROOT-LESION (*Pratylenchus* sp.) – 50/g of dry root
Please note: Spiral (*Helicotylenchus* sp.) nematodes do not have an established threshold for economic damage in Ontario. Please check references on specific host crop(s) for more information.

* All *Aphelenchoides* sp. were detected in very low numbers.

Diagnostician: Christ. Blaser

Christine Blaser (cblaser@lsd.uoguelph.ca)
Phone: (519) 767-6256 Fax: (519) 767-6240

Report sent: September 22, 2000

PDC-003 (03/07/01)

Southern Crop Protection & Food Research Center
P. O. Box 6000
4902 Victoria Avenue North
Vineland Station, Ontario
Canada L0R 2E0

September 29, 2000

Pest Diagnostic & Advisory Clinic, OMAFRA
Agric. & Food Laboratory Services Centre
P.O. Box 3650
95 Stone Road W., Zone 2
Guelph ON N1H 8J7

Re: Strawberry nematode identifications

We have examined the two sets of samples of nematode material from strawberries, submitted by you on Sept. 26, 2000 for species identification. For reference, the samples were designated as "Crown" and "Root".

In the "Crown" sample, after cleanup, we found one nematode, identified as a free-living specimen of the family Rhabditidae, ie. not a plant parasite. We found no evidence of Aphelenchoides sp. in the submitted material.

From the "Root" material, we found 31 specimens of the genus Pratylenchus. These included 1 adult male, 6 adult females, and 24 juveniles of various stages, mainly 3rd and 4th stage, which were all examined and identified to species. The entire group of 31 were identified as Pratylenchus penetrans.
The identified specimens were consistent in having 3 head annules with a slightly set-off lip region, a rounded (non-crenate) sub-cylindrical tail, and distinctly round stylet knobs. The adult female specimens had the post-uterine sac length about equal to the vulval body width, a spherical spermatheca, and vulva at about 80% of body length. The adult male specimen had typical spicules and the annulated bursa surrounding the tail tip. Body dimensions of both males and females fit the type description of P. penetrans. In my opinion, the identification was consistent for all specimens.

Yours truly,

John W. Potter
Nematologist

☎: 905/ 562-4113 ext 232
FAX: 905/ 562-4335
E-✉: potterj@em.agr.ca

UNIVERSITY of GUELPH LABORATORY SERVICES

Report

PEST DIAGNOSTIC CLINIC
DIAGNOSTIC REPORT

Date sample received: 00/09/01 **Lab I.D. #:** PDC00-1631 to 1640

Submitter: James Lokken
Saskatchewan Strawberry Plant Producers
410-9th Street East
Saskatoon, SK
S7N 0A8

Owner: n/a

Host: strawberry (cultivar Camarosa)

Diagnosis: Root lesion nematodes (*Pratylenchus* sp.) were extracted from the roots of the 10 samples submitted (sampled on a forty foot grid and composited on a one acre basis as required by the California Department of Food and Agriculture). Apart from small numbers of spiral nematodes (*Helicotylenchus* sp.), no other plant pathogenic nematodes were detected.

Comments and/or Observations: Dr. John Potter, nematologist with the Agriculture and Agri-Food Canada Southern Crop Protection & Food Research Centre, has identified the root lesion nematodes isolated as *Pratylenchus penetrans*. No other *Pratylenchus* species were present in the strawberry roots submitted.

Visit us on the web at www.uoguelph.ca/pdc

Diagnostician:

Marc Sabouri, M.Sc. F. (msabouri@lsd.uoguelph.ca)
Phone: (519) 767-6256 Fax: (519) 767-6240

Report sent: October 2, 2000

Appendix B. Labeling and Documentation Used in Strawberry Plant Shipment to California: SSPP 2000

Appendix B presents examples of the various labels required by USDA, State of California and University of California regulations on boxed shipments of strawberry plants across the US, California and county borders. The University of California requirements apply to shipments of UC patented varieties only.

Clarence Peters, SAF, provided Nursery Stock Inspection Certificates in both letter and box-label form which are similar to those carried on boxes of certified California plants. All of the labeling and documentation was accepted at all three borders without any problems.

Nursery Stock Inspection Certificate
Province of Saskatchewan, Canada

The plant materials, nursery premises, and storage and packing facilities from which this shipment originated have been visually inspected by Saskatchewan Agriculture and Food and found free from especially injurious insect pests and visible disease symptoms.

Inspected by: C. C. Peters, Fruit Development Specialist
Saskatchewan Agriculture and Food
Sustainable Production Branch
3085 Albert Street, Regina , Saskatchewan S4S 0B1
Telephone: (306) 787-4666

Disclaimer of Liability
Saskatchewan Agriculture and Food disclaims all liability for this plant material. The responsibility for performance failure, diseases, and off-types shall lie solely with the grower, whose name and address appear on this tag.

Grower: Saskatchewan Strawberry Plant Producers
Address: 410 9th Street East, Saskatoon, Saskatchewan Canada S7N 0A8
Variety: Camarosa Certifield Level
Date: October 6, 2000

Saskatchewan
Agriculture
and Food

Walter Scott Building
Regina, Canada
S4S 0B1

October 6, 2000

Nursery Stock Inspection Certificate

I, the undersigned, C. C. Peters, Fruit Development Specialist, Saskatchewan Agriculture and Food

Sustainable Production Branch
3085 Albert Street,
Regina, Saskatchewan, Canada S4S OB1
Telephone (306) 787-4666

HEREBY certify that the following products:	**Certified level bareroot strawberry plants** **Variety: Camarosa**
BEARING the marks:	**Saskatchewan Strawberry Plant Producers** **410 9th Street East** **Saskatoon, Saskatchewan, S7N 0A8**
SHIPPED from:	**Saskatoon, Saskatchewan, Canada**
AND consigned to:	**various, California, USA**
TRANSPORTED by:	**Martin's Vegetable Sales, Trailer #116**

Originated from fields inspected on June 20, 2000 and September 22, 2000, and were found to be essentially free of insect pests, including leafhoppers and plant bugs, and free of visible signs of plant disease symptoms. The Nursery premises, storage and packing facilities, were also inspected on September 22 and found to be clean and suitable for the purpose.

Disclaimer of Liability

Saskatchewan Agriculture and Food disclaims all liability for this plant material. The responsibility for any performance failure, diseases, and off-types shall lie solely with the grower, whose name and address appears on this document

Dated at:_____
Saskatoon, Saskatchewan

Signed:_____
Clarence C. Peters
Fruit Development Specialist
Saskatchewan Agriculture

Strawberry Plant Camarosa

U.S. Plant Patent Number 8,708
Canadian Plant Patent Number 93-261

Licensee is a non-exclusive licensee of the University of California in the United States and is granted the right to propagate the cultivar Camarosa in Canada.
U.C. Control Number 2000.01.5056

Warning: Unlicensed propagation and transfer (sale) of the University of California strawberry cultivars for fruit production outside of the United States and Canada is **PROHIBITED.**

Harvested October, 2000

At Saskatoon, Saskatchewan,

CANADA

1250 Camarosa Strawberry Plants

-bareroot and leaves removed
-propagated from California Registered Stock

Produced by:

Saskatchewan Strawberry Plant Producers
410 - 9th Street East
Saskatoon, Saskatchewan
S7N 0A8
CANADA
Telephone (306) 653-4038

Product of Canada

Product of Canada

Perishable

Appendix C. Southern California Customers: SSPP 2000

Mr. Will Doyle 6397 Chassee VENTURA CA 93003	Mr. Bill Ito/Mr. Steve Ozawa 9112 McFadden Avenue Westminster CA 92683 USA
Eclipse Berry Farms Attn: Mr. Jim Carter 11812 San Vicente Blvd. Los Angeles CA 90049	James Y. Nakamura Co. Inc. Attn: Mr. Gary Y. Nakamura 5900 N. Rose Avenue P.O. Box 1172 OXNARD CA 93032
Mr. John Dullam 195 Victoria Avenue OXNARD CA 93030	Nakama Ranch Attn: Mr. Chas Nakama 1980/2204 South Rice Avenue P.O. Box 5623 OXNARD CA 93031

Mr. Bill Ito, Mr. Steve Ozawa, Mr. Chas Nakama, and Mr. John Dullam have all cooperated with Dr. Tanino in Saskatchewan plant trials at various times in the last several years. They are all well-known southern California growers.

Mr. Jack Gresser has indicated an interest in testing Saskatchewan plants. He has strawberry interests in the Santa Maria area and in Florida. Growers in the Santa Maria area do not plant as early as in southern California so are not interested in paying more for early plants but they may be interested in a new source of vigorous plants.

Mr. Jack Gresser
Central West Produce
511 E. Main Street
Santa Maria CA 93454